VOL. XXXI NO. 5 MARCH, 1938

PROCEEDINGS *of the* ROYAL SOCIETY OF MEDICINE

LONGMANS, GREEN & Co LTD
39 PATERNOSTER ROW, LONDON
NEW YORK · BOMBAY · CALCUTTA · MADRAS

Section of Epidemiology and State Medicine

President—Sir ARTHUR MACNALTY, K.C.B., M.D.

[*January* 28, 1938]

The Utilization of Lethal Gases in Hygiene

By P. G. STOCK, C.B., C.B.E., M.B., F.R.C.P., (Hon.) F.R.C.S.Ed., D.P.H.

THE use of lethal gases in preventive medicine can be traced to remote times, and the burning of sulphur to purify the air is mentioned by Homer, whilst Hippocrates refers to the process as an antidote to plague.

In the time available it is impossible to present an exhaustive account of the increasing number of lethal gases or the various uses to which they are put on health or economic grounds, and it is hardly necessary to point out that the two do not always go hand-in-hand. It may, therefore, be more convenient to summarize the uses for which lethal gases are employed, then briefly to consider the application of various gases to the end in view, and illustrate some of the details by lantern slides.

The uses for which lethal gases are employed may be grouped conveniently under the following heads :—

(1) The destruction of pathogenic organisms, in the process which is commonly spoken of as disinfection.
(2) The disinfection of water, or the partial disinfection of sewage effluents.
(3) The destruction of rodents, both as an antiplague measure on ships and in the field, and to reduce the number of vermin.
(4) The destruction of insects concerned with the spread of disease, such as lice, fleas, and mosquitoes.
(5) The destruction of insect pests such as cockroaches, moths, and bed-bugs.
(6) Mainly on economic grounds, for the destruction of insects which sometimes infest or are found in connexion with the storage of certain foodstuffs—such as dried fruits, cocoa, and grain. It will be well to emphasize, however, that the fumigation of foodstuffs as an economic measure is by no means always devoid of risk to health.
(7) For the destruction of various kinds of agricultural pests, such as the tobacco moth, &c., the best-known example perhaps being the scale insect of citrus trees.

The use of a lethal gas for executing criminals, as sometimes carried out in the United States, is a social rather than a public-health measure.

It is unnecessary to dwell on the use of gases for disinfection, as the processes are well known. Moreover, the practice of terminal disinfection is gradually being abandoned, but when gaseous disinfectants are used, probably sulphur, in some form, after centuries of use, still holds pride of place in spite of its modern rival formaldehyde gas.

The sterilization, or partial sterilization, of water and sewage effluent is a subject in itself, and outside the scope of this paper. Chlorine or chlorine and ammonia are

being increasingly used, and one of the largest firms in the country supplies over 1,200 tons of liquid chlorine per annum for the treatment of water and sewage.

To consider briefly the various methods of application: It is obvious that the greatest effect will be obtained with a given quantity of fumigant if the space to be dealt with is made as gas-tight as possible. The methods of rendering vessels or buildings gas-tight and the preparatory opening-up of closed spaces in order to provide easier access thereto for the gas need not be described beyond noting that when rendering spaces gas-tight the question of subsequent ventilation should be borne in mind.

For fumigation purposes gases are commonly generated by combustion, by chemical action, or by releasing the liquefied gas which may be either (*a*) stored under pressure in metal cylinders, or in stout glass containers, or (*b*) absorbed in a porous medium. Each of these methods of generation is employed in practical fumigations, and much thought and ingenuity have been devoted to increasing the measures for safety, efficiency, and easier handling.

In practice the only gases generated by combustion are the oxides of sulphur, with which may be associated carbon dioxide, and the mixture of carbon monoxide and carbon dioxide produced in the Nocht-Giemsa process.

The methods of burning sulphur in shallow trays or buckets with due precautions against fire are well known, and as far back as 1891 Clayton at New Orleans devised his well-known apparatus for the fumigation of ships with the oxides of sulphur in connexion with the control of yellow fever.

A more recent innovation has been the use of "Salforkose", a patent liquid preparation which is occasionally used at ports in Germany and this country. Salforkose consists of a mixture of carbon bisulphide and alcohol which is burnt in a special form of iron pot protected with "baffle" plates to damp down the flame and minimize risk of fire. On the addition of water to the mixture an aqueous solution of alcohol rises to the surface of the carbon bisulphide which, when ignited, generates sufficient heat to vaporize the underlying carbon bisulphide at a steady rate. The vapour of the carbon bisulphide then rises through the layer of alcohol and water and burns with the alcohol, though apparently the actual flame does not reach down to the surface of the carbon bisulphide. Small quantities of formaldehyde and other irritant compounds are found in the mixture, but the method really resolves itself into a rapid generation of sulphur dioxide plus some carbon dioxide.

The mixture of carbon monoxide and carbon dioxide utilized in the Nocht-Giemsa method has to be generated in a special furnace which is difficult to transport, and the method is now used only in a few ports for the destruction of rats. It is claimed that the gas is highly penetrating, but on the other hand it does not kill fleas, and the Commission on the Fumigation of Ships, when reporting in 1932, expressed the opinion that the process would be entirely replaced by newer methods of fumigating. It is interesting to recall, however, that when suspicion first attached to ship-borne rats as likely agents in the diffusion of plague, carbonic acid was one of the first fumigants considered [1].

The common method of generating hydrogen cyanide, when it first came into use as a fumigant, was to add sodium cyanide to a mixture of sulphuric acid and water contained in earthenware crocks or wooden barrels [2]. The number and placing of the containers throughout the space to be fumigated had to be carefully organized if the fumigation was to be successful and the risks attending the operation eliminated. Much ingenuity was displayed in devising methods for avoiding the risks associated with hand-dumping, such as wrapping the sodium cyanide in paper bags, and in ship fumigation the bags were lowered by a string from an upper hatchway into the container on a lower deck. Other arrangements were to have a tipper attached to the wooden barrel operated by a cord which could be pulled from the open air or by a timed water balance or even a clockwork device. Another was to provide a length of rubber tubing, one end of which discharged into the barrel, the other being carried

into the open air and fitted with a funnel down which a solution of sodium cyanide was poured.

Other developments were the use of portable machines to generate the gas outside the space that had to be fumigated and to lead the gas by a pipe to where it was required (fig. 1).

Several machines of this nature were devised, one of the earliest being the Young "cyanofumer", which was designed for the fumigation of citrus trees. Others are the generator designed by Dr. Grubbs of New York; the "Grima" machine used in Spanish ports; and the "Sanos" apparatus used at Havre. In these types of machine the gas is generated in a strong metal container by allowing a measured

FIG. 1.—Type of generator used on a United Fruit Company boat (New York Harbour).

quantity of cyanide (either as a solid or in solution) to fall from an upper compartment into a lower chamber containing a mixture of acid and water. The pressure evolved or compressed air then drives the gas along a flexible pipe into the space to be fumigated. A much more accurate machine (fig. 2) was devised by Colonel Glen Liston [3] in which the hydrogen cyanide is produced by running measured quantities of a solution of sodium cyanide and a mixture of acid and water into a generating-box connected by pipes with the compartment to be fumigated. Air is drawn from the compartment and through the machine by a fan which dilutes the gas and forces it along an outlet pipe back into the compartment. As more gas is generated, more air is drawn from the compartment into the machine. The mixture of air and gas in the compartment is thus continuously circulated through the machine, more gas being added until the

desired concentration is obtained. One of the objects of the Glen Liston machine was to avoid the high and dangerous concentrations which develop under the ordinary dumping methods. Most of these machines—owing to their weight, the difficulties in handling the piping, and the problem of safe disposal of the residues—have been superseded by newer methods. Calcium cyanide is also used for generating hydrogen cyanide. In the presence of damp air calcium hydroxide is formed and hydrogen cyanide is liberated as a gas. To a certain extent the reaction is reversible, which must be borne in mind when disposing of residues. The material can be obtained in the form of briquettes (when it must be ground to a powder) or as a fine dust, which is distributed by some form of blower. The use of the dust is advocated in the United States for injection into rat harbourages on vessels, as the danger from the gas being held in these harbourages, and later escaping into the ships' holds after they have been ventilated, is considered to be negligible. Risks during application can be entirely obviated if the operator wears a suitable mask. Apparatus is also on the market wherein the hydrogen cyanide is extracted by air in a large bag, and the gas-

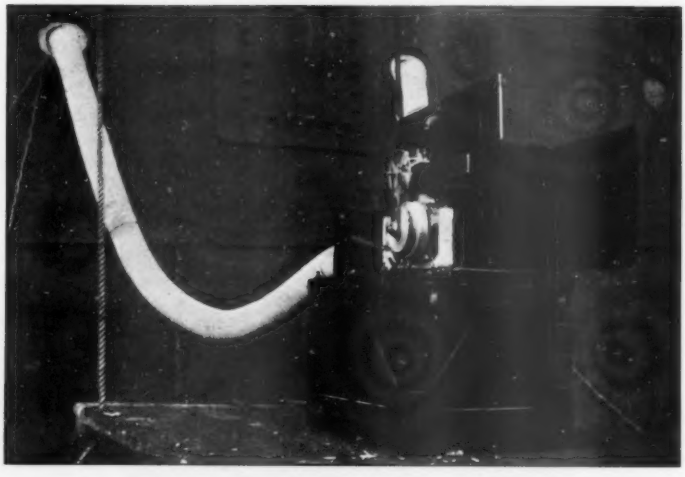


FIG. 2.—Glen Liston apparatus in use for fumigating a ship (London Docks).

laden air, free from dust, is delivered through a hose, which obviates the cleaning problem.

The only other gas produced by chemical action which is commonly used is cyanogen chloride gas mixture; this is generated in a similar way to hydrogen cyanide, but sodium cyanide, sodium chlorate, talc, and hydrochloric acid, are used in place of sodium cyanide and sulphuric acid, the talc being for the purpose of moderating the reaction. It is claimed that the resulting gas consists of cyanogen chloride and hydrogen cyanide in molecular combination, and as the former is highly lacrymatory, the presence of a dangerous gas is readily detected. Cyanogen chloride gas mixture is used in Scottish ports, some 130 vessels being fumigated by this method during 1936.

Many of the difficulties inherent in the older methods of applying lethal gases have been overcome by utilizing the liquefied gas—which may be sprayed, poured into trays and allowed to evaporate, or, in the case of hydrogen cyanide, absorbed in a porous medium, such as Kieselguhr or wood pulp. A small percentage of an irritant

and lacrymatory gas may also be added as a warning and safeguard against accidents. When Kieselguhr[1] is the medium the finished product is a granular earthy substance not unlike coarse sand, which is sold under the trade name of "Zyklon"[2]. If wood pulp or papier mâché is used the medium is cut into round discs which are commonly known as "Discs" or "Discoids". Both preparations are put up in hermetically sealed tins, the net hydrogen cyanide content printed on the labels being taken as the basis for dosage. When a fumigation is to be carried out the tins are opened with due precautions and the contents distributed on trays or sheets of paper which facilitates subsequent removal of the residue. In cold weather, raising the temperature hastens the evolution of the gas.

The advantages of spraying the liquefied gas are that the dosage is easily measured, the fumigant is applied in the most favourable form for rapid vaporization, and there

FIG. 3.—Delayed-action sprinkler for reinforcing the dose of heavy naphtha.

are no residues. Moreover, the gas can be applied from the outside of a building and the operator need not enter the space to be fumigated when the gas is applied.

Much ingenuity has been expended in designing suitable sprays for the object in view and types vary from a simple "Flit" spray, which is worked by hand, to elaborate apparatus worked by compressed air supplied by an air-compressing machine similar to those used in painting plants. Only a few types will be mentioned here. The air-jet sprayer for liquid hydrogen cyanide used by the United States Quarantine Service is an adaptation of the ordinary oxy-acetylene blowpipe, a modification being the "air-jet gun" for projecting the fumigant directly into rat harbourages.

Another type of machine (fig. 3) is the delayed-action sprinkler described by Ashmore and McKenny Hughes in their reports on the use of heavy naphtha for the

[1] The process is similar to the Nobel process for the manufacture of dynamite which is prepared by the absorption of nitro-glycerine in granular, silicious earth, mostly "Diatomit".

[2] Formerly known as Zyklon B. Originally Cyklon or Zyklon A was cyanogen carbonic methyl ester and the lacrymatory gas was chloro-carbonic methyl or ethyl ester, a liqiud said to have been prepared by the Germans for gas warfare but not to have been used, owing to the termination of hostilities.

destruction of bed-bugs. When using heavy naphtha (for house fumigations) it was found that in the unfavourable conditions presented by a leaky house, the requisite percentage of saturation might not be maintained for the necessary period, and the need was felt for a reinforcing dose to be applied without unsealing about half-way through the twenty-four-hour period of exposure. The machine consists essentially of a metal reservoir, which is filled with naphtha, connected with a number of revolving jets operated by clockwork. At any desired time an alarm-clock mechanism starts the sprayer and the revolving jets automatically distribute the liquid in the reservoir and so reinforce the falling saturation.

The technique of application of atomized sprays is by no means fully developed, but there is a machine operated by compressed air now on the market which will disseminate into the atmosphere a liquid in the form of such an extremely tenuous mist that it remains in suspension without condensing on or wetting the walls, &c., up to the saturation point of the atmosphere. One of the latest devices is the Larmuth apparatus designed in Durban for the disinsectization of aircraft. It consists of a small steel tube containing the dose of insecticide and an exit pipe connected by a varying length of copper piping with one or two fine atomizers. The power for operating the spray is obtained from an ordinary sparklet bulb, which has only to be inserted and screwed down until it is punctured when the rush of the compressed carbon dioxide, which issues at a pressure of about 90 lb. to the square inch, is sufficient to discharge and atomize the dose of insecticide.

Lethal gases in liquid form are supplied in heavy steel cylinders—to withstand the pressure and rough usage in carriage. To overcome the difficulties in handling the large cylinders, the contents, before a fumigation, are frequently transferred into smaller containers. The containers should be fitted with a tube leading from the outlet valve to the periphery of the container, so that the contents can be drawn off either as a gas or a liquid. If the container is placed upright—that is, with the valve at the top—and the valve opened, the accumulated gas under pressure will be blown off and can be led by a tube into the space to be fumigated.

On the other hand, if the container is inverted or tilted so that the valve is at the lowest point before being opened, the contents will be forced out as a liquid which, if sprayed, evaporates rapidly. In carrying out a fumigation the pressure may be increased by pumping in air and the outlet is connected with the delivery tube, ending in a suitable form of sprayer.

The first procedure is quite limited in its application, due to the fact that as soon as the accumulated gas in the top of the cylinder has been blown off the rate of delivery is markedly reduced. C. L. Williams, working at the Quarantine Station, New York [4], found that from a 150 lb.-cylinder of liquid sulphur dioxide about 20 lb. of gas can be obtained at ordinary temperatures in the first half-hour, but the amount then falls until the rate of delivery is only about 3 lb. per hour. The reason for this is that sulphur dioxide has a high latent heat of vaporization, so that evaporation results in marked chilling, which, in turn, slows down the rate of evaporation, and the only way to hasten evaporation of the liquid is to heat it. In the Marot process the liquid is passed through a copper coil heated, in one form of the apparatus, by the exhaust from a gasoline motor. On the other hand, by inverting the cylinder and forcing the contents out as a liquid through a sprayer, the contents can be rapidly introduced into any compartment, as the gas pressure in a 150-lb. cylinder of sulphur dioxide is sufficient to empty completely an inverted cylinder in from ten to twenty minutes.

It is absolutely essential, however, that the sprayer and the inside of the delivery tube should be free from water. If even comparatively small amounts of water are present the chilling caused by evaporation of the sulphur dioxide will freeze the water in the narrow outlet of the sprayer and block it. If the tube and sprayer are dry, however, it will function perfectly.

It is essential, of course, that the application of a lethal gas should be properly controlled, and one method of doing this is to measure the gas concentrations achieved in the space under fumigation. This can be accomplished by aspirating and testing samples of the atmosphere, or by the vacuum-bottle method. If a number of tests have to be carried out, e.g. in a large ship, the aspiration method becomes impracticable, and in the earlier investigations carried out in this country by Monier-Williams and the writer, vacuum-bottles were used, opened from the dock side by an electric current [2]. The original apparatus has been greatly improved on by Page, who has devised a 1-litre round-bottomed flask which admits the sample of air through a capillary tube in the cork when a glass septum is fractured by electromagnetic action [5]. The flask is enclosed in a lined metal container and the whole apparatus is compact, portable, easily manipulated, and suitable for use in places difficult of access.

There are other methods of ascertaining whether a sufficient quantity of gas has penetrated the spaces dealt with. A common method in house and furniture fumigations is to leave insects in some form of container in the deeper recesses and to observe the result when the house or van is opened up. As far back as 1894 Tilghmann took out a patent for a hot-wire type of combustible gas indicator, the principle being that the burning of a combustible gas on the surface of an electrically heated metallic filament increases its electrical resistance which can be measured on a galvanometer.

When the spraying of orthodichlorbenzene was being tried for the destruction of bed-bugs, Ashmore and Buchan, of the Government Laboratory, developed a rapid and approximately quantitative test for orthodichlorbenzene vapour in air. A specially designed lamp, as used for the detection of leaks in refrigerating systems using chlorinated hydrocarbon as refrigerants, was adapted for the purpose. The lamp burns pure methyl alcohol and the flame impinges on a ring of metallic copper. In pure air the flame has a pale blue colour which at once changes to green in the presence of small amounts of orthodichlorbenzene vapour. The test is made roughly quantitative by fitting to the pure air supply pipe a T-piece and valve which allows admixture of such a volume of the air under test that the flame just ceases to show a green coloration.

Heerdt has also described what he terms the mousephone. A mouse in a box, connected with earphones, is placed in the space to be dealt with, and by listening to the movements the time can be fixed when the animal is overcome with a lethal concentration.

It is naturally of paramount importance to ensure that spaces or articles which have been fumigated are free from the lethal gas before they are handed back to the owners. The precautions can only be summarized here. The main consideration is to ensure adequate ventilation for a sufficient time to remove the gas not only from the free air space but also from hidden spaces and from materials which may have absorbed it. Unless this is ensured a dangerous concentration may slowly build up, if any space which is being ventilated after fumigation is closed up too soon. Lethal gases may be absorbed on to the surface of materials and fabrics and during a fumigation the gas will slowly penetrate into the interior of absorbent materials and enter hidden spaces (such as the interior of floors, walls, &c.). The process of absorption will continue as long as there is gas in a closed space, the rate of removal depending largely on the ease with which gas being given off is removed by airing. Natural ventilation largely depends on the atmospheric conditions outside and ventilation may take longer in cold weather and certain other conditions of the atmosphere.

Various systems of artificial ventilation have been suggested for shortening the time of airing—such as the Grubbs aerothrust, canvas, wind-chutes, &c. The objections are usually the difficulties involved in handling the plant but where the saving of time is of importance much may be accomplished by the use of compressed air. In cold weather particularly, ventilation is slow and as the temperature rises, gas may be liberated from materials which have retained it. Under such circum-

stances it may be necessary to reclose and heat compartments and retest them before they are passed as free from gas. In Spanish Ports, after fumigations with hydrogen cyanide, if the ventilation is delayed, the space to be dealt with is occasionally sprayed with some aldehyde to neutralize the gas, but the method has not been generally adopted [6].

With some gases such as sulphur dioxide there is no difficulty in deciding whether the ventilation has been sufficient. With others, such as hydrogen cyanide, much greater care must be taken, and it is highly dangerous to rely on the sense of smell for detecting the presence of this gas even if a small amount of a lacrymator has been added.

C. L. Williams has pointed out [7] that there are two distinct dangers connected with the use of warning gases. One is, that when present in sufficient quantity to be actually intolerable they constitute a menace to the fumigators, who may be rendered helpless by the effects of the warning gas. Tear gases, for example, may get inside a gas mask in sufficient amount to blind the fumigator. The other danger is that the warning gas, if used for instance with hydrogen cyanide, may disappear before the hydrogen cyanide does, so that fumigators, misled by the absence of warning gas, may declare a place safe when it is not. Williams goes on to say that two cases of this nature have occurred on ships in his own experience, and he attributes the failure to the fact that hydrogen cyanide is absorbed by porous materials while the warning gas, not being absorbed, is blown away by air currents. Upon its disappearance the compartment may be declared safe and closed, but the absorbed hydrogen cyanide is slowly liberated and passes into the now confined area in which it produces an unsuspected dangerous concentration. Birds, which are particularly susceptible to hydrogen cyanide, or small animals exposed in cages, may be used for determining the condition of the atmosphere and various chemical tests have been devised which depend on a colour change in the presence of the gas.

The common test for the presence of hydrogen cyanide is to expose strips of filter paper which have been wetted with a solution of copper benzidine acetate. The paper turns blue in the presence of hydrogen cyanide, but the solution must be freshly prepared and other precautions must be observed. Investigations are now being carried out on behalf of the Bug Infestation Committee of the Medical Research Council as to the best technique for the test, but it may be well to emphasize that the most essential general precaution is to ensure that fumigations with lethal gases are only carried out by trained and responsible persons who have full knowledge of the gas they are handling and of the precautions which must be taken.

To return now to the third group of uses for lethal gases, namely, the destruction of rodents. Ever since the recognition of the fact that the plague is propagated more by rats than by man, the efforts of sanitarians all over the world have been directed to the prevention of rodent-borne infection. The principle was recognized in the International Sanitary Convention of 1903, extended in the Convention of 1911, and under the Convention of 1926 all foreign-going ships have to be periodically deratized (every six months) or be permanently so maintained that any rat population is kept down to the minimum. These provisions have led to a great increase in the number of vessels fumigated with lethal gases for the destruction of rats. The first vessel to be deratized with sulphur dioxide at an English port was the S.S. *Royal Dane* on December 22, 1899, which was fumigated with cylinders of liquid sulphur dioxide at the River Tyne. Hydrogen cyanide was first authorized as a fumigant in the United States Quarantine Regulations in 1910, and the first vessel fumigated with this gas at an English port was the S.S. *Scythia* (19,730 tons gross register) at Liverpool on March 17, 1922.

Since that date the number of vessels fumigated with hydrogen cyanide at Ports in Great Britain which are authorized to issue the international form of certificate has increased greatly. Thus in 1936 some 345 vessels were fumigated with hydrogen

cyanide, 128 with cyanogen chloride (all at Scottish Ports), 653 with sulphur, 7 with Salforkose, and 6 with hydrogen cyanide and sulphur. Incidentally, it may be of interest to mention that the greatest number of rodents destroyed on a vessel as the result of fumigation, that the writer can recall, was 1,879 mice on a grain-carrying vessel that arrived at Naples in 1932, while 535 rats were destroyed in the Port of London, in July 1937 on the S.S. *Somali*, which was suspected to be plague-infected. Nowadays, such figures are most exceptional, and during 1936 about 80% of the vessels examined at the "Approved" Ports in Great Britain were granted certificates exempting them from deratization.

The increase in the number of vessels that had to be fumigated to comply with the requirement of the International Sanitary Convention of 1926 naturally gave rise to a good many problems, and it soon became apparent that a good deal of investigation was necessary if fumigations were to be really effective, without which of course they are merely a waste of time and money and only bring Port health measures into disrepute. An International Commission on the Fumigation of Ships was therefore set up in 1928 by the Health Committee of the League of Nations, in consultation with the Permanent Committee of the Office International d'Hygiene publique. Amongst other questions the Commission investigated the efficiency of fumigation of loaded ships, which may present particular difficulties, as absorption of gas by cargo may occur, with consequent rapid reduction of concentration. The report [8] of the Commission was published in 1932, but some work had still be to done in regard to the efficiency of sulphur as a fumigant, which was being queried by the advocates of cyanide.

There had been little research since the classical investigation by Haldane and Wade which had proved that rats and fleas could be destroyed in less than two hours by the uniform diffusion of at most 0·5% of sulphur dioxide. A series of experiments was therefore planned and carried out in the Port of London [9], the fumigations being strictly on the lines which would have been followed if they had been done with the object of granting an international deratization certificate. The main object was to ascertain definitely whether the amount of gas present at various points was such as would support the considered opinion of Port Medical Officers of Health in this country that the fumigation of empty ships by burning sulphur was quite sufficient for the destruction of rats. As a check, and for the purpose of comparison, the experiments were repeated with hydrogen cyanide. Contrary to expectation the fumes from burning sulphur appear to enter "pipe-casings" more readily than those of hydrogen cyanide, the explanation probably being that burning sulphur in open pans sets up convection currents which improve the distribution of the gas. The results were submitted to the Permanent Committee of the Office International d'Hygiene publique [10] and provisional standards for international adoption have been issued in regard to the quantities and periods of exposure which should be given when vessels are fumigated with hydrogen cyanide or sulphur dioxide for the destruction of rodents.

Only one other substance need be mentioned in connexion with the fumigation of ships for the destruction of rats, namely, the vapour of chloropicrin (trichloro-nitro-methane) $CHCl_3 NO_2$, which has been advocated by Sequy, Bertrand, Marshall Balfour [11], Piedallu [12], and others either as an insecticide or for the destruction of rats on ships. The eggs and larvæ of most insects, including white ants, can be destroyed, and chloropicrin is largely used in the French Army [13] for the destruction of bed-bugs. It is also probably one of the constituents of some secret insecticides.

The liquid has a boiling point of about 112° C. and as it is only slightly soluble in water the concentration is little affected by the presence of moisture. When vaporized it is a strong lacrymator. Unfortunately, it is highly lethal and as the vapour is heavy, the subsequent ventilation, particularly of a ship, may be very prôlonged. The difficulties and delays in ventilation, and the fact that chloropicrin decomposes

into phosgene in the presence of water vapour, are considered by many authorities to render it unsuitable for use.

Rodents may also have to be destroyed in the field as an anti-plague measure and for this purpose resort is often made to "gassing". Carbon bisulphide and the various forms of slow-burning cartridges have their use, but in South Africa, where extensive epizootics of plague have occurred amongst the wild rodents, the use of calcium cyanide (cyanogas) has been found the most satisfactory method. The dust is pumped into the holes and burrows—preferably at night—and the hydrogen cyanide that is liberated kills the rodents and their fleas.

Lately a good deal of attention has been given to the extermination of rabbits with hydrogen cyanide, generated by blowing calcium cyanide or a new preparation, "Cymag" into the burrows. Fears have been expressed that the process would render the flesh of the rabbits toxic, but inquiries seem to indicate that little danger is to be anticipated.

The practice is increasing of using fumigants for the destruction of insects concerned with the spread of disease. When typhus fever was particularly prevalent in parts of Europe shortly after the Great War, delousing stations were established on the Polish-Russian border where clothing, baggage, and railway carriages were fumigated with hydrogen cyanide [14]. Similar measures were taken at frontier stations in Holland; Cyklon A was used and was found to be particularly effective in destroying the eggs as well as the lice themselves. About the same time some steam disinfectors at the Quarantine Station, New York, were converted for use as vacuum chambers for delousing with hydrogen cyanide the baggage of immigrants from Europe. The vacuum method is mainly used to secure better and quicker penetration of a fumigant, but it is also claimed that the creation of a vacuum results in de-oxidation, which lowers the resistance of insects to poisonous gases. For instance, it is stated that weevils are killed much more readily in a vacuum with ethylene chloride or ethylene oxide. Special vacuum chambers for use with lethal gases are now on the market.

Fumigations solely for the destruction of fleas are seldom necessary, but when vessels are fumigated as an anti-plague measure the aim, of course, is to destroy both rats and their fleas. In connexion with the outbreaks of plague in Ceylon, L. F. Hirst [15] has stressed the part played by fleas and how grain traffic facilitates their transport. In his report he suggests a mechanical fumigating conveyor for exposing bags of grain to a dose of cyanide adequate to ensure complete pulicidal penetration. The fumigation of grain cargoes from plague-infected ports is now practised in Ceylon, where this measure is considered "to constitute the first line of defence against a danger which is ever present" [16].

It is only occasionally that vessels have to be fumigated for the destruction of mosquitoes, which are readily killed, and high concentrations of any gas are unnecessary. The practice of spraying habitations for the destruction of adult mosquitoes, however, is growing, and as an anti-malarial measure [17] has met with marked success in Natal and Zululand (fig. 4). The insecticide commonly used when spraying is some preparation of pyrethrum—which can hardly be classed as a lethal vapour—but occasionally mixtures containing carbon tetrachloride and oil of wintergreen are also used. It seems possible that some of the newer forms of thiocyanates will prove reliable insecticides, but it is too soon to say whether the claims that they are non-lethal to human beings will be upheld on further investigation.

The problem of the disinsectization of aeroplanes, however, particularly as a precautionary measure against the spread of yellow fever, is now under consideration by the Office International d'Hygiene publique, but it may be well to point out that no fumigant should be used which will leave traces that may affect the pilots in the air.

When lethal gases are used for the destruction of insects, special problems frequently arise—partly owing to the variability of resistance of different types. Thus,

turning to the fifth group of uses, it is found that the cockroach and the ordinary clothes-moth display an unexpected degree of resistance to certain fumigants. The destruction of cockroaches [18] on shipboard is not a recognized quarantine procedure, although there is some evidence that they may contaminate foodstuffs. From the point of view of the officers and crew of a vessel, however, the destruction of insect pests, particularly cockroaches, is the criterion by which the effectiveness of a fumigation is judged, and little consideration is given to what is usually its specific purpose, namely, to kill rats. Much stronger concentrations of hydrogen cyanide are required to kill cockroaches than to destroy rats, and this must be allowed for in the compartments infested if extermination is to be accomplished.

FIG. 4. –Spraying a native hut (Zululand).

The fumigation of houses for the destruction of clothes-moths is seldom done. The fumigation of two houses in London with a mixture of ethylene oxide and carbon dioxide, which has come under review, appears to have been singularly ineffective. The writer, however, recalls an occasion in the early summer of 1925 when with Monier-Williams he was present at the fumigation of a large house in Kent, which was alive with moths. It was impossible to open a drawer or turn up a mat without disturbing swarms. Over 85 kilos of hydrogen cyanide were used, which gave an estimated concentration of 2% by volume—this high concentration being aimed at owing to the difficulty in destroying the eggs.

Passenger-coaches on the railways sometimes become infested with moths, fleas, and other insects, and may then have to be dealt with. One method in this country

is either to spray the interior of the coaches with tetrachlorethane or to inject the liquid into the upholstery by means of a powerful hand-pump fitted with a needle nozzle. The operators wear a mask fitted with a tube carried out of the compartment into the open air.

A good deal of work has been done recently on fumigation problems arising in connexion with the work of disinfestation. Following the publication by the Ministry of Health of a report on the bed-bug—which also dealt with methods of extermination—the Medical Research Council set up a Committee to carry out further investigations. Generally speaking, the problem of disinfestation is being attacked along two main channels. Firstly, the disinfestation of the belongings of families in transit between infested dwellings and clean houses; and secondly, the disinfestation of houses already verminous in which the tenants have to remain. When furniture has to be dealt with it is collected in vans and commonly fumigated with hydrogen cyanide, either by generating the gas in the van itself or by running the van into a special fumigating chamber.

Investigations bearing on van fumigations have been carried out by the research department at Billingham, to which I am permitted to refer, thanks to the kindness of Imperial Chemical Industries, Limited. Furniture materials were fumigated with hydrogen cyanide in an experimental steel container, and one of the interesting points noticed was that even a small quantity of rust in the chamber caused rapid decomposition of some of the hydrogen cyanide, and it was necessary to "pickle" the chamber periodically.[3] It was also found that the wooden flooring of a steel van absorbed some of the hydrogen cyanide, and an unexpected difficulty in cleaning one van was traced to the presence of water underneath the floor-boards, indicating the need for suitable precautions when working in wet weather.

Considerable absorption by furniture occurs, and on occasions it has been found that a steel van loaded with treated furniture may be aired until the van is apparently free from hydrogen cyanide, but that if the van were sealed up dangerous concentrations could build up overnight. As the contents of the van would, however, be unloaded into a number of rooms the hydrogen cyanide concentrations could not possibly build up to the extent which it may do in a closed van overnight.

Stuffing material for furniture—such as flock, wool, and horsehair—offers little or no mechanical resistance to the rapid diffusion of hydrogen cyanide, but an appreciable time is required to develop a lethal concentration in the interstices of such material, owing to their absorptive powers. At a depth of three inches in stuffing material (which is regarded as the greatest thickness likely to be encountered in ordinary upholstered furniture) about half an hour is required to develop a hydrogen cyanide concentration equal to 80% of the external concentration. From such materials the rate of removal of absorbed hydrogen cyanide is determined solely by the rate of desorption, so that provided the air rate of ventilation is sufficient to maintain a negligible hydrogen cyanide concentration in the free air space, any increase in the air rate is without effect.

In a summary of the work it is stated that an efficient and safe procedure for van fumigations with hydrogen cyanide is to fumigate for two hours with a dosage of 1·2% vol/vol of the van space followed by airing for four hours, using an air rate of 200 M^3/ hour. This permits the complete cycle of operations, including loading and unloading the furniture, to be carried through in a shift of eight hours.

The behaviour of hydrogen cyanide with various building materials was also investigated in connexion with the construction of fumigating chambers. It was found that the extent of absorption varies widely for different materials [19], but the subject is outside the scope of this paper.

The fumigation of houses, and especially furnished houses, presents problems of

[3] The necessity for "pickling" did not arise in the case of the steel furniture van. Two coats of good oil paint would of course get over this difficulty.

its own, and progress in the use of hydrogen cyanide has been marred by some unfortunate accidents. On one occasion the bedding, as well as the other contents, were fumigated. The following morning when the inmates returned, some smell was noticed but the premises were slept in. During the night two fatalities occurred, and it seems clear that sufficient hydrogen cyanide had been retained in the bedding gradually to build up a lethal atmosphere. Some carefully controlled investigations on house fumigations (fig. 5) under summer and winter conditions, have since been carried out under the auspices of the Medical Research Council and a report is shortly to be published.

FIG. 5.—Battery of sampling flasks outside a house under fumigation with hydrogen cyanide.

It is well recognized that fumigations with hydrogen cyanide are not always practicable, and as the evidence as to the efficacy of sulphur dioxide for destroying bed-bugs was conflicting, investigations were also carried out on behalf of the Medical Research Council by Mr. H. C. Gough, working under Professor J. W. Munro, of the Imperial College of Science. A preliminary note on the results published in *Nature* 1938, **141**. 164, confirms the general view that sulphur dioxide is a good insecticide but a poor ovicide. Mr. Gough found that a concentration of from 0·16% to 0·23% by volume, is sufficient to kill the adult and nymphal stages of the bed-bug in two and a half hours at 23° C. and 60% relative humidity, but it requires from 0·34% to 0·63% (vol/vol) to kill the eggs. Eggs just after being laid are considerably more

resistant than those about to hatch, and—curiously—the adult insect, when starved, shows an increased resistance.

The spraying of undiluted orthodichlorbenzene has also been tried and has given very satisfactory results as far as the destruction of bed-bugs is concerned. Unfortunately, there is reason to think that the fumes from certain concentrations may be toxic to human beings [20], and the use of orthodichlorbenzene for occupied houses has been discontinued.

Ashmore and McKenny Hughes then suggested the use of heavy naphtha [21], and a good deal of experimental work was carried out, with the collaboration of Dr. Macmillan of Woolwich, and Dr. Cameron of University College Hospital Medical School, whose investigations [21*a*] into toxicity of the preparation offer considerable assurance that there will be no danger to human beings from an atmosphere saturated with a vapour of heavy naphtha. Very promising results have been obtained in Woolwich, Liverpool, Kensington, and elsewhere. The requisite technique includes raising the temperature, if below 60° F., and reinforcing the concentration. A van or chamber process of disinfestation with heavy naphtha has also been developed, and promises well. Details of the technique, however, and the excellent results obtained in Liverpool have recently been described by Ashmore, Macmillan, and Glover (of Liverpool) at a sessional meeting of the Royal Sanitary Institute.

Ethylene oxide is also sometimes employed for the destruction of bed-bugs, but the gas is intensely inflammable, and when used is mixed with varying proportions of carbon dioxide. Etox, or T. gas, consists of 90% ethylene oxide and 10% carbon dioxide and is supplied in large steel cylinders, but in practical fumigations small glass syphons are commonly used which are first filled from the large cylinders, and additional carbon dioxide subsequently added. Using Etox, De Bruyne [22] concluded that in houses which are suitable for gassing, a concentration of about 2½% by volume and an exposure of from eight to ten hours gave satisfactory results. Unless the building can be made gas-tight, however, fumigation is useless whilst low temperatures and moisture increase the difficulties of ventilation. A mixture of one part of ethylene oxide and nine parts of carbon dioxide is marketed in the United States under the trade name of "Carboxide", and has been used for the fumigation of ships [23]. Cotton and Roark considered [24] that the vapour of ethylene oxide was not highly toxic to man, but Walker and Greeson [25] consider that the precautions to be taken should be as thorough against this substance as against any other dangerous gas.

The fumigation of foodstuffs with lethal gases is done on economic grounds as a remedy for insect infestation and to prevent loss of trade, as purchasers will not continue to buy brands of products in which they have found evidence of insect infestation. In drawing attention to the growing practice, Williams estimated [26] that during the year 1931 in the United States alone 700,000,000 cu. ft. of building space (mostly warehouses, flour mills, &c. containing foods), 500,000,000 lb. of commodities (mostly foods, in fumigation chambers), 4,000 ships (many of them loaded), and 7,000 railway freight cars (loaded and empty) were fumigated. He considered that the practice was growing, and that similar figures for 1932 would show a 10 to 25% increase.

Most health officers no doubt will deprecate the treatment of foodstuffs with toxic gases and will prefer that insect infestation should be controlled by improving the conditions under which foodstuffs are handled, transported, and stored, rather than trusting to the potency of chemical agents to destroy the visible manifestations of insect activity.

Various fumigants have been used, such as carbon bisulphide, hydrogen cyanide, and ethylene oxide, and no doubt new fumigants will appear from time to time. For the effect on foods of fumigation with hydrogen cyanide the reader is referred to the report by Monier-Williams [27]. The operations may be carried out in specially

designed buildings, in vacuum chambers, and even in railway vans. In this country dried fruits have been fumigated in the barges into which they have been unloaded from an incoming vessel [28]. At one time the efficiency of this barge fumigation does not appear to have been very high, and it is suggested that insects survived and were carried into warehouses which, in turn, became infested [29]. A good deal of investigation has, however, been carried out under the direction of Prof. J. W. Munro of the Imperial College of Science, and an efficient system of barge fumigation has been worked out, but the complete elimination of insects from infested warehouses is a much more difficult problem.

The fumigation of grain is sometimes carried out as an anti-plague measure, but is mainly done for the destruction of weevils. It is a problem which has already arisen in France [30] and may arise in this country if larger stores of grain are held for longer periods. The fumigations may be done with hydrogen cyanide, chloropicrin, or ethylene oxide. If ethylene oxide is used, for the fumigation of grain in bulk, it may be applied by pouring it over crushed solid carbon dioxide at the rate of 1 lb. to 10 lb. of "dry ice", and the mixture is then shovelled into the stream of grain on the bin floor of an elevator.

According to Schwarz and Deckert, 90% of ethylene oxide is removed by twenty-four hours' aeration, and whilst the amount retained in foods may be small it may be well to mention that in the presence of water at ordinary temperatures a limited amount of ethylene glycol may be formed. The fate of ethylene glycol in the body is not known, but there is a possibility that it may be oxidized to oxalic acid.

The fumigation of flour mills is carried out for a slightly different purpose. If the flour moth (*Ephestia kühniella* Zeller) once gets established in a mill the cocoons and debris may accumulate to such an extent in elevators, "worms" conveyors, and other machinery, as even to lead to clogging of feed rolls and frequent stoppages.

As far as the writer is aware, the first time that a mill was fumigated in this country was in March 1925 when liquid hydrogen cyanide was used with most satisfactory results. To be successful the operations should be carefully organized by experienced fumigators, and preferably should be carried out when stocks are low and there is ample time for the subsequent ventilation.

The fumigation of orchards, tobacco sheds, greenhouses, &c., and the use of substances such as chlorinated hydrocarbons [31] in fire extinguishers or as refrigerants in refrigerating systems, the vapour of which may be toxic if leakage occurs, are outside the scope of this paper.

With the increasing use of lethal gases, however, it is perhaps not surprising that accidents have occurred. In most cases they can be ascribed to failure to observe the well-recognized and necessary precautions. Time does not permit of any summary being given, but in July last an Act was passed (Hydrogen Cyanide (Fumigation) Act, 1937) to regulate the fumigation of premises and articles with hydrogen cyanide, and draft regulations have just been gazetted. Whilst the Act at present deals only with the use of hydrogen cyanide, its provisions can, if necessary, be extended, by Order in Council, to regulate fumigations with any substance.

REFERENCES

1 Report of Med. Off. Hlth., Local Govt. Bd., 1900-1901, Appendix.
2 Stock, P. G., and Monier-Williams, G. W., Rep. Minist. Hlth. on Pub. Hlth. and Med. Subj., No. **19**, 1923.
3 Glen Liston, W., and Goré, S. N., *J. Hyg.*, 1923, **21**, No. 3.
4 Williams, C. L., *Pub. Health Rep.* Wash., U.S.A., 1934, **49**, 637.
5 Page, A. B. P., *J. Soc. Chem. Industr.*, 1932, **51**, No. **46**.
6 *Bull. Office internat. d'hyg. pub.*, 1922, **14**, 124.
7 Williams, C. L., *Pub. Health Rep.*, Wash., U.S A., 1931, **46**, No. 18.
8 *Bull. Hlth. Org. League of Nations*, **1**, No. 2.
9 Stock, P. G., Monier-Williams, Lubatt, and White, *Bull. Hyg.*, 1924, **9**, No. 2.
10 *Bull. Office internat. d'hyg. pub.*, 1934, **26**.

11 *Internat. J. Pub. Health*, 1920, p. 384.
12 PIEDALLU, *Bull. Office internat. d'hyg. pub.*, 1930, **22**, 763.
13 GOURNELLE and RAOUL, "Rev. du Service Militaire", 1937, p. 881.
14 STOCK, P. G, *Proc. Roy. Soc. Med.*, 1924, **17** (Sect. Epid., 9).
15 HIRST, L. F., "The Protection of the Interior of Ceylon from Plague", 1931.
16 Report of the Ceylon Board of Quarantine, 1936.
17 *Bull. Hlth. Org. League of Nations*: Rep. Pan-Afr. Conf., **5**, 1.
18 RIDLON, J. R., *Pub. Health Rep.*, Wash., U.S.A., 1931, **46**, 1623.
WILLIAMS, C. L., *Pub. Health Rep.*, Wash., U.S.A., **46**, 1680.
19 SCHWARZ and DECKERT, *Ztschr. f. Hyg. u. Infectionskr.*, 1928, **109**, 281.
20 CAMERON, G. R., and THOMAS, J. C., *J. Path. and Bact.*, 1937, **44**, 281.
21 ASHMORE, S. A., and MCKENNY-HUGHES, A. W., *Brit. M. J.*, 1937 (i), 459; *Lancet* (i), 530.
21A CAMERON, G. R., PATERSON, J. L. H., DE SARAM, G. S. W., and THOMAS, J. C., *J. Path. and Bact.*, 1938, **46**, 95, 107.
22 DE BRUYNE, M. F., *Techn. Maandbl. v. Gemeenterein*, No. **1-4**, 1938.
23 BROWN, E. W., *Naval Med. Bull.*, No. 3, 1933.
24 COTTON and ROARK, "Industrial and Engineering Chemistry", 1928.
25 WALKER, J. W. G., and GREESON, C. E., *J. Hyg.*, 1932, **32**, 409.
26 WILLIAMS, C., *Am. J. Pub. Health*, Wash., U.S.A., 1933, **23**, 561.
27 MONIER-WILLIAMS, G. W., Rep. Minist. Hlth. on Pub. Hlth. and Med. Subj., No. **60**, 1930.
28 PORTER, C., *Ann. appl. Biol.*, 1935.
29 Id., *ibid.*
30 *Lancet*, 1937 (ii), 205.
31 Med. Res. Council Sp. Rep. Series, No. **80**, 1937.

Proceedings of the Royal Society of Medicine Vol. XXXI 443

Section of Anæsthetics

President—I. W. MAGILL, M.B.

[*December* 3, 1937]

The Errors of Flow-meters and the Advantages of a New Type of Constriction

By R. K. SCHOFIELD, M.A., Ph.D.

Rothamsted Experimental Station, Harpenden

IF the closed (carbon-dioxide-absorption) method of administering anæsthetic gases is to be used to full advantage, flow-meters are needed that can register rates as low as 10 c.c. per minute with a fair degree of accuracy. The purpose of this paper is to survey very briefly the problems which must be solved in the production of such instruments, to indicate the errors to which the various types are prone, and to point out the advantages of a new type of constriction.

In all flow-meters the gas generates a pressure difference between the two sides of a constriction through which it is made to pass. The instruments fall into two main groups—the fixed-pressure type and the fixed-constriction type.

The fixed-pressure type.—In this, the pressure difference is fixed, and the size of the constriction varies with the flow rate. The constriction may, for instance, be the clearance between a bobbin and the wall of a tapering tube, in which case the fixed-pressure difference is due to the weight of the bobbin. There are several alternative arrangements embodying essentially the same idea. The problems that arise are :—

(1) How to eliminate friction that would make the pressure difference greater for rising than for falling flow rates ;

(2) How to prevent an enlargement in the clearance, due to wear, permitting an increasing flow to pass in excess of that registered.

Great ingenuity in design and care in manufacture are required to solve both problems simultaneously. It is doubtful whether there is any instrument yet available in this group of which it may confidently be said that when it registers 50 c.c. per minute one may be sure that not more than 60 c.c. and not less than 40 c.c. is actually passing. The best may perhaps do this when new, but we do not know how great the error may be after they have been in use for some time. Some of the instruments in use at the present time can only be described as dangerously inaccurate.[1]

The fixed-constriction type.—In this group, the constriction is fixed and the pressure difference is measured. Here the problems are :—

(1) To choose a suitable constriction and reduce to a minimum the risk of its properties being altered (e.g. by dirt, moisture, or corrosion).

(2) To provide a convenient and sufficiently accurate means for measuring the pressure difference.

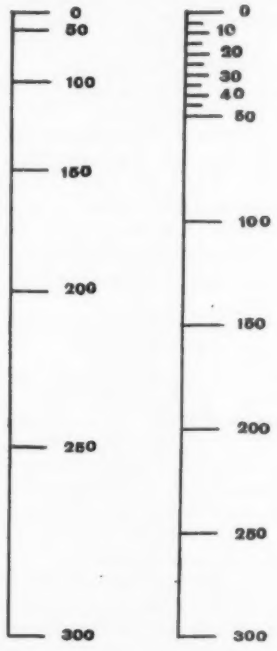
Again the difficulty is the *simultaneous* solution of the two problems. A Bourdon pressure gauge is convenient and sufficiently accurate, provided the pressures are high enough, but the very fine constrictions which have been used to obtain the necessary pressure differences have proved to be undesirably susceptible to partial blockage. A water depression manometer is much more sensitive and so permits the use of wider constrictions, but as hitherto constructed it is larger and more troublesome to transport and also less easy to read. It is quite possible, however, that these drawbacks which have hitherto made "wet" flow-meters unpopular may be considerably reduced by improvements in design.

A new type of constriction.—With the fixed constrictions hitherto employed the pressure difference varies roughly as the square of the flow rate. Thus in a water

[1] Errors amounting to several hundreds per cent. have been reported, and the author has been informed that cyclopropane "dissolves" vulcanite bobbins.

depression flow-meter the depression increases nearly fourfold for a twofold rise in flow rate. Consequently the markings for the smallest flow rates are crowded against the zero, as shown on one side of the figure. It is, however, possible to get an evenly spaced scale, such as that shown on the other, by using as constriction a set of long capillaries arranged in parallel. The gas passes through a constriction of this kind in " stream-line " motion, and the pressure difference, which is controlled by the viscosity of the gas, is directly proportional to the flow rate (very nearly). The motion through a hole or jet is " turbulent ", and the pressure difference is due mostly to the necessity of giving a high kinetic energy to the gas as it rushes through the constriction ; hence its dependence on the density and the square of the velocity.

By using a constriction that gives direct proportionality between pressure difference and flow rate, in conjunction with a water manometer, full use can be made of



the fact that a manometer has a true zero. With this arrangement the smallest flow rate gives a proportional movement of the liquid surface from the zero mark. With dry flow-meters there is always " threshold " flow below which the instrument does not register. In the fixed-pressure type this tends to increase with wear, and is a serious source of error.

It is a comparatively simple matter to make an accurate manometer flow-meter, using a set of parallel tubes as constriction, since Nature has provided such a constriction ready made in a stick of cane (not bamboo but " solid " cane). A piece about the size of a pencil can be selected to give a water depression of 2 in. for 100 c.c. per minute. Thus a 6-in. depression tube will register flows up to 300 c.c. per minute and will give one-tenth of an inch depression for 5 c.c. per minute. One depression tube could be given two scales, one for high and one for low sensitivity if two canes, one of which would be cut out for high sensitivity, were connected in parallel. In this way the scale could be extended to, say, 6 litres per minute, without lengthening

the instrument or generating excessive pressure differences. There would be no real difficulty in making an instrument on this principle that would give an error not exceeding ± 5 c.c. per minute below 100 c.c. per minute, or ± 5% for higher readings. Blockage of the cane is the only possible source of error. The risk of this seems to be very slight in view of the many hundreds of channels through which the gas may pass, but it is a point that will have to be checked under practical conditions.

An instrument using a cane or equivalent system of metal tubes and a manometer of improved design seems most likely to combine the needed accuracy with moderate cost, as no highly specialized technique is involved in its construction. The possibility must not, however, be overlooked that a similar constriction might prove satisfactory in conjunction with a sensitive Bourdon gauge.

Need for frequent checking.—In conclusion it should be stressed that *all* flow-meters that are used in closed circuit work should be periodically checked. It is to be hoped that instruments will soon be available that are of such proved dependability that the checking need only be done at long intervals, but as matters stand at present the checking should be frequently done. Testing apparatus is cheap to assemble and comparatively easy to use.

The Continuous-Flow Administration of Cyclopropane

By Lawrence H. Morris

The method of continuous-flow administration of cyclopropane was excellently described by Burford in 1936.

An anæsthetic apparatus capable of measuring very small flows of gas is essential, but there are no flow-meters which measure accurately flows below 100 c.c. per minute down to about 10 c.c. per minute. A special apparatus was therefore constructed.

Apparatus.—The apparatus is composed of three parts—a footpiece, an upright rod, and a head ; these fix together by means of male and female joints and also fit into a small box container. The head has three yokes to take nitrous oxide, oxygen, and cyclopropane cylinders. Nitrous oxide flows at the rate of 1–10 litres per minute, oxygen at 100 c.c. – 1 litre per minute, and cyclopropane at 10–300 c.c. per minute. The flows are measured by means of calibrated gauges, which are, in fact, pressure gauges with a fixed restriction valve at the outlet. When the pressure is increased, the flow of gas increases and it is really this pressure, which is calibrated, and not the actual flow of gas.

Disadvantage.—This restriction type of flow-meter appears to have one disadvantage, in that the rate of flow of the gases falls (it never increases), and so does not correspond to the reading shown on the dial. This occurs gradually after some hours of use and for no accountable reason, although it may be due to very small particles of dirt or moisture from the gauges and the gases clogging the restriction valves, but there is no definite proof of this. The restriction valve must therefore be reset from time to time in order to overcome this disadvantage. As this apparatus is purely experimental, no emergency valves for a fast flow of oxygen have been fitted, but I have always had an oxygen cylinder at hand and have, so far, not had cause to use it.

Technique.—In conjunction with this apparatus I use a Waters to-and-fro soda-lime canister.

To induce, I start oxygen flowing alone at 1 litre per minute. After fixing the face-mask, and with the bag only slightly distended, I set cyclopropane flowing immediately at 300 c.c. per minute, which is the highest limit of flow at my disposal. I feel, however, that it would make induction easier and quicker in certain cases, if this limit was higher, say 400 or 500 c.c. per minute—but not more—for in most cases 300 c.c. suffices. After enough of the mixture has passed into the bag to prevent it from collapsing completely at the end of an inspiration, the rate of oxygen flow is reduced to 350–400 c.c. per minute, cyclopropane remaining at 250–300 c.c. per minute. When the desired level of anæsthesia is reached, cyclopropane is then cut

down to 100–150 c.c. per minute and oxygen to 230–300 c.c. per minute, in other words to as near the basal rate as can be judged, the bag being full enough to accommodate the tidal respiration. Thereafter the flow of cyclopropane is very gradually reduced, depending upon the plane of anæsthesia desired. This rate can be anywhere between 100–20 c.c. per minute, but I find that the lower rate is not reached until at least thirty minutes have elapsed. This, no doubt, is due to the fact that the blood and tissues have not become fully saturated with cyclopropane until then. Should greater depth of anæsthesia be required, the rate is increased another 10–40 c.c., which is usually sufficient.

Observations.—Induction is generally smooth and I have noticed no untoward signs such as cessation of respiration, arrhythmia, bradycardia, or tachycardia, which may occur with a faster rate of flow of cyclopropane administration. I also feel that with this continuous-flow method of administration of cyclopropane, one can maintain the level of anæsthesia required with the greatest of ease, mainly due to the fact that there is a continual replacement of this gas, lost at the site of the wound, from skin evaporation, and from gas-bag and connexion leakages. In addition, the necessary amount of gas required for anæsthesia is maintained.

My experience covers a variety of operations, varying from those requiring deep anæsthesia—such as gall-bladder operations, to those requiring light anæsthesia—such as perineal repairs and cystoscopies.

With the first two cylinders (20 gallons capacity) of cyclopropane I used, the cost per case, taking on the average 58 minutes' duration and using 1½ gallons, was approximately 2s. 9d. This, I think, compares favourably with any other method.

Reference.—Burford, G. E. (1936), *Current Researches in Anæsth. and Analg.*, **15**, 254-259.

[*February* 4, 1938]

The Trend of Modern Anæsthesia for Upper Abdominal Surgery

By H. K. Ashworth, M.B., M.R.C.S., D.A.

Ten years ago anæsthesia for upper abdominal surgery was comparatively easy. Ether was not only the foundation, but also the superstructure of deep anæsthesia. As there was practically no alternative, except chloroform or C.E. mixture, everyone was more or less satisfied.

Nowadays the patient makes three very sensible demands: (1) To go to sleep in bed. (2) Eventually to wake up. (3) Not to be sick.

The surgeon demands: (1) Profound muscular relaxation. (2) Minimal abdominal respiratory movement. (3) Minimal bleeding due to the anæsthetic agent. (4) Minimal anæsthetic shock. (5) Minimal post-operative saturation with toxic anæsthetic drugs. (6) Minimal use of respiratory irritants.

The trend of modern practice is to aim at fulfilling all these requirements not, as a rule, with one set drug or technical method, but with a combination of drugs and methods of administration, such as: (1) Local infiltration. (2) Basal narcosis combined with nitrous oxide and oxygen, carbon dioxide absorption plus minimal ether or vinesthene, added as adjuvants for short periods during the operation. (3) Spinal anæsthesia. (4) Basal anæsthesia plus cyclopropane.

I should like at the outset to draw a very clear distinction between anæsthesia for emergency—and anæsthesia for "quiet"—upper abdominal surgery. I will deal first with the latter.

There is one welcome trend, which will I hope, with the ever-growing co-operation of surgeons, become rapidly established. This is the realization of the enormous benefit to the ambulatory patient of undergoing some part of his preparation for a week or more before operation. One can appreciate and sympathize with the natural reluctance of an ambulatory patient to delay entry to a nursing home or hospital until the last possible moment, but it seems to me that a period of two weeks, or even of one week, of training for the heavy physical strain of an upper abdominal operation

and anæsthetic is eminently sensible. The suggested measures, which involve no great hardship, are : (1) Treatment of any existing dental sepsis. (2) Reduction to a minimum of tobacco and alcohol consumption. (3) Bed-time at 10 p.m. (4) Progressive reduction of daily time spent at business, with, if conditions permit, increased time spent in fresh-air surroundings. (5) Careful attention to bowel action and permitted dietary. (6) Assimilation of glucose during the forty-eight hours before operation. (7) Avoidance of contact with persons suffering from nasopharyngeal infections. The ideal would be to hand a printed slip containing these or similar directions to every patient at the time when the operation is decided upon, explaining that they are devised solely to secure his greater comfort and well-being during and after operation and anæsthesia.

(1) *Local anæsthesia.*—In a consideration of the actual anæsthetic drugs for quiet upper abdominal surgery, it is convenient to begin with local anæsthesia.

The recent work of Ogilvie (1935) has rekindled interest in this method, particularly in gastric and duodenal surgery. The advantages claimed for it are that : (i) It is non-toxic. (ii) It is comparatively bloodless. (iii) There are no post-anæsthetic complications.

It has occurred to me—as an observer of several cases operated upon by means of this technique—that it has three disadvantages, namely : (i) More time is required for the operation. (ii) The operative field is limited, and a general exploration of the abdomen is impossible. (iii) Profound shock may occur ; in one case it was necessary to introduce an intravenous saline during operation in order to combat an alarming fall in blood-pressure.

Until the introduction of cyclopropane, it was probably the method of choice in the surgical treatment of bleeding ulcer in the pale, thin, anæmic patient, with a low blood-pressure, a soft rapid pulse, and little vital reserve. It will be interesting to observe the future trend of anæsthesia for this particular type of case. My guess is that, in this country at any rate, in a few years' time cyclopropane may possibly be considered preferable to local anæsthesia.

(2) *Basal narcosis*, combined with nitrous oxide and oxygen, carbon dioxide absorption, with minimal ether or vinesthene as an adjuvant.

With the use of a long-acting basal narcotic, such as avertin, this method yields good results. My own practice is to pour vinesthene into the empty chloroform bottle of whatever apparatus I happen to be using. When it is used in this way, as an adjuvant, the total time of administration, even during a long operation, does not exceed the safe limit of thirty minutes suggested by authorities (Bourne, W., and Raginsky, B. B., 1935) beyond which liver damage might occur. The drawback to this method is that it subjects smoothness of anæsthesia to some degree of hazard, as for example when a cholecystectomy is nearing completion, the level of anæsthesia is comparatively light, and the moment arrives to add ether or vinesthene. One is so easily caught on a Morton's fork. Either one increases the respiratory volume so that the comparative peace existing within the abdomen is disturbed, or else one strengthens the vapour too quickly, and straining results.

(3) *Spinal anæsthesia.*—This method, using the 1 : 1,500 solution of percaine, undoubtedly provides ideal muscular relaxation, and minimizes both abdominal respiratory movements and hæmorrhage. The needs of the patient may be satisfied by the administration of a minimal dose of a short-acting barbiturate such as evipan, prior to the actual intrathecal puncture, with a continuation of unconsciousness by means of nitrous oxide and oxygen.

It is unfortunate that a long-acting basal narcotic, such as avertin, does not go well with high spinal anæsthesia, because this combination would theoretically supply satisfaction to patient, surgeon, and anæsthetist. I may have been unlucky, but I have not been happy in my experience of avertin and high spinal block. I saw too often the ominous restless movements of the arms and head, accompanied by sighing respiration, not heralding recovery from avertin, but denoting the presence of a

dangerous degree of anoxæmia. Despite often repeated contrary statements, some degree of fall in blood-pressure, is a normal physiological accompaniment of high spinal anæsthesia, and the conjoined use of any basal narcotic other than a minimal dose of a short-acting drug is to be condemned, as it also inevitably causes some degree of respiratory depression, and fall in blood-pressure.

One difficulty which is sometimes encountered, particularly in hospital practice, is that of the alcoholic type of patient. undergoing a gastric operation under high spinal anæsthesia, who does not take kindly to the administration of light nitrous oxide and oxygen, and with the unanæsthetized portion of his anatomy, makes a creditable attempt, in difficult circumstances, to struggle.

High spinal anæsthesia alone, except for a preliminary dose of omnopon, scopolamine, and ephedrine, is possibly the best anæsthetic for this type of patient. Unfortunately, this method nearly always disturbs the patient because of what I call the " vago-traction-nausea " reflex. I tried to overcome this by persuading the surgeon as soon as he had opened the abdomen, to infiltrate round the œsophageal opening of the diaphragm with 1% novocain solution, in order to block, at any rate partially, the passage of vagal stimuli. This was a great success until on one occasion, shortly after the novocain injection, a patient suddenly complained of respiratory embarrassment. Having hastily verified the fact that the spinal anæsthetic had not extended upwards to the cervical region, I suddenly realized that the novocain solution had blocked not only the vagi, but also, evidently, the terminal distributive branches of the phrenic nerves. The patient made a good recovery, but this method of blocking the " vago-traction-nausea " reflex stands condemned.

There is one upper abdominal operation, more or less of election, for which I cannot help thinking that the trend of anæsthesia will be increasingly to use high spinal block. I refer to the operation for the relief of obstructive jaundice, particularly when due to a stone tightly wedged in the common bile-duct, necessitating, for adequate surgical access, both profound muscular relaxation and minimal abdominal respiration.

At the moment, there appear to be only two anæsthetic agents which will fulfil these exacting surgical requirements yet will add no further burden to an already badly damaged liver function. These are high spinal block, with or without nitrous oxide and oxygen, and cyclopropane. I have hesitated to use cyclopropane, in view of the delayed coagulation time of the blood in jaundiced patients, and it will be interesting to hear later any reports of its use in such cases.

(4) *Basal narcosis and cyclopropane.*—A useful combination is a dose of 0·075 or 0·08 grm. per kilo body-weight of avertin, plus atropine gr. $\frac{1}{100}$, in order to counteract any increased secretion, under cyclopropane anæsthesia, which appears to be largely thin salivation in the mouth, and not, as when ether is used, thicker pharyngeal mucus. The addition of cyclopropane gives a resulting anæsthetic which provides good muscular relaxation, and which, in my limited experience, appears to be non-toxic, and also non-irritant to the respiratory tract. The high percentage of accompanying oxygen essential during the administration of so powerful an anæsthetic agent as cyclopropane is of great advantage at the time, although it may become a drawback during recovery. Another advantage of cyclopropane is the ease with which it lends itself to Guedel's method of artificial control of respiration, which is often so helpful to the surgeon during delicate manœuvres in the upper abdomen.

The disadvantages of avertin and cyclopropane are : (1) The comparatively high cost of administration. (2) Occasional difficulty in obtaining muscular relaxation before respiration has become depressed, and even after resource to squeezing the rebreathing bag. Probably this is due more to technical inexperience than to the fault of the drug ; this was certainly my impression in the two cases of this nature which I have encountered. (3) Increased blood-pressure, with consequent increased bleeding. My observation is that oozing in the tissues of the abdominal wall is increased, but that there is little or no noticeable increase in intra-abdominal hæmorrhage. I have used avertin and cyclopropane for quiet cholecystectomy uncom-

plicated by jaundice, without any noticeable increase in oozing from the raw surface of the liver, or complaint on this score from the surgeon. (4) As has been pointed out (Nosworthy, 1937) a patient who has for an hour or more lived in an atmosphere rich in oxygen and carbon-dioxide absorption may become anoxæmic if his respiratory system is suddenly decontrolled and left to breathe ordinary atmospheric air. I have on one occasion encountered this complication, and am still puzzled as to the correct physiological technique of decontrol. The one which I employ is to shut off the absorber as soon as the peritoneum is closed. Whenever respiration begins to deepen, the expiratory valve is opened and the administration of nitrous oxide and oxygen is begun, with a cautious addition of carbon dioxide when the respiratory rate and volume have increased to normality. During the skin suturing and application of dressings, the patient is disconnected from the machine for intermittent periods of atmospheric breathing before the administration of gases is finally stopped.

The following case provides an illustrative example of the scope and use of avertin and cyclopropane in upper abdominal surgery :—

The patient, a man aged 57, was admitted to hospital on June 8, 1937, with a history of intermittent left-sided abdominal pain of ten months' duration, and for eight months, of a swelling in the left upper abdomen and of embarrassed respiration, both of which had since steadily increased. He had had a laparotomy performed elsewhere six months previously, with no relief, and was now at the end of his tether.

On examination.—The patient looked ill and anæmic. He had a large abdominal tumour arising from below the left costal margin and extending downwards to the umbilicus and two inches to the right of the mid-line. For a week before operation, the pulse-rate varied between 84 and 108 and the respiratory rate between 20 and 26. The blood-pressure; rather surprisingly, was 140/80. The blood-count was as follows: R.B.C. 2,230,000; Hb. 42%; C.I. 0·95; W.B.C. 9,400.

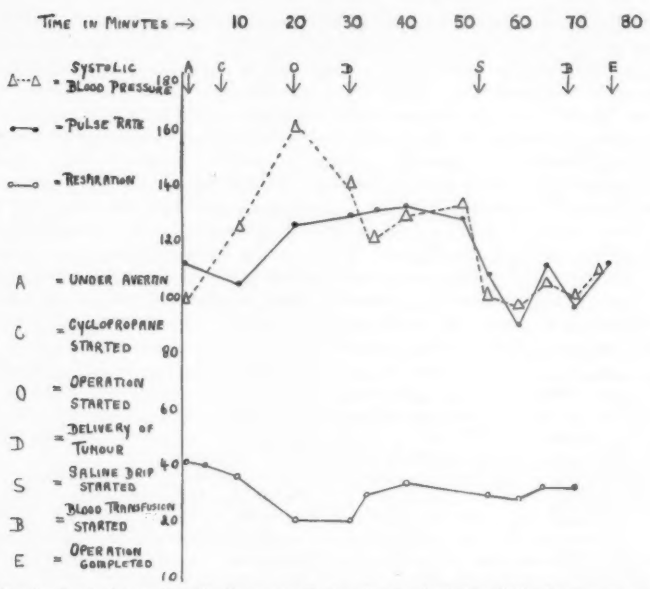
In the case of this very ill man, with no vital reserve, and with this huge tumour, the problem was to decide which anæsthetic would give him the best chance of leaving the table alive. He was given 0·075 grm. of avertin per kilogram, atropine gr. $\frac{1}{65}$, and cyclopropane. The actual operation was even more difficult than had been anticipated. The tumour was a vascular retroperitoneal sarcoma, inseparable from the spleen, the posterior wall of the stomach, and the tail of the pancreas. It was removed *en masse*, and stomach was repaired. 600 c.c. of citrated blood were administered intravenously, during operation, and the patient was returned to the ward on a blood-drip.

The accompanying chart (p. 8) shows a typical rise of blood-pressure and fall in respiration after the commencement of administration of cyclopropane. This patient survived the immediate post-operative period, but unfortunately died two days later, probably from peritontis.

It is, of course, quite impossible to prove, but one cannot help feeling that this patient would have died on the table without the stimulating help of cyclopropane.

Next I put forward for consideration the problem of anæsthesia for emergency upper abdominal surgery. In this type of case—dealing as we so often are, with a patient whose physical resources are already severely taxed by shock, or toxæmia, or dehydration, or even by all three—it is of the utmost importance that no extra strain shall, if avoidable, be contributed by anæsthetic drugs, which may be respiratory irritants, added toxins during excretion, or likely to produce post-anæsthetic vomiting. An added difficulty is the distension and rigidity so often associated with an acute abdominal lesion, and necessitating, for adequate surgical treatment, deep anæsthesia. In adult patients, provided that the general condition is sufficiently good, spinal anæsthesia, and nitrous-oxide-and-oxygen is perhaps the only anæsthetic which seems to fulfil the requirements of the surgeon without adding to an already existing toxæmia, except when the emergency is due to intraperitoneal hæmorrhage.

The proviso as to the general condition of the patient is important. It is impossible too often to reiterate that spinal anæsthesia is the sure way of killing the moribund, and particularly the dehydrated patient suffering from acute intestinal obstruction. The blood-volume of such patients is so shrunken that they are unable to cope with the physiological fall of blood-pressure under high spinal anæsthesia, and a fatal medullary anæmia results. A patient suffering from acute intestinal obstruction



Anæsthesia chart of case described on page 7, showing typical rise of blood-pressure and fall in respiratory rate after the commencement of administration of cyclopropane.

should receive at least 1½ pints of normal saline intravenously before spinal anæsthesia is even considered.

For the poor risk, or for the patient suffering from intraperitoneal hæmorrhage, unfitted for spinal anæsthesia, there were, until recently, only two alternatives—gas-oxygen-ether, calculated to bring the patient safely through a hurried operation, but liable fatally to tip the scale in the depressing reaction inevitably associated with recovery from ether anæsthesia, or local field-block, perhaps with gas-and-oxygen, and some limitation of surgical access. Cyclopropane has possibly supplied a new trend in anæsthesia for these most anxious cases, as illustrated by the following :—

A short, stout woman, aged 75, and weighing approximately 15½ stones, was operated upon for torsion of the pedicle of an ovarian cyst. Although not strictly an upper abdominal operation, there were two factors which made it worthy of this classification, namely that the pedicle was long, and the cyst adherent, and that there was considerable associated reflex abdominal distension, which had, to some extent, obscured the diagnosis. The patient was extremely ill and collapsed, and, as anti-shock treatment was ineffective, operation became imperative. One hour before operation, she received omnopon gr. ⅓, scopolamine gr. $\frac{1}{300}$, and atropine gr. $\frac{1}{100}$, on account of the presence of slight chronic bronchitis. Cyclopropane was administered, resulting in a noticeable improvement in the general condition, and the provision of adequate anæsthesia. Convalescence, although anxious owing to her age and poor general condition, was uninterrupted until the eighteenth day after operation, when a pulmonary infarct developed, but she is now making a good recovery.

Whatever may be said as to the undesirability of the rise in blood-pressure associated with cyclopropane or carbon dioxide absorption (for the blame has not yet conclusively been apportioned), a rise in blood-pressure is welcome to the anxious anæsthetist in this type of case. Doubtless it may be achieved with gas-oxygen and ether, but only with the possibility of detrimental after-effects which, in my limited experience, are fortunately lacking after the administration of cyclopropane.

References.—BOURNE, W., and RAGINSKY, B. B. (1935), *Brit. J. Anæsth.*, **12**, 62; NOSWORTHY, M. D. (1937), *Brit. M. J.* (ii), 809; OGILVIE, W. H. (1935), *Brit. M. J.* (i), 457.

Section of Orthopædics

President—A. Rocyn Jones, F.R.C.S.

[*December* 7, 1937]

Lesions of the Supraspinatus

By V. H. Ellis, F.R.C.S.

Disabilities of the shoulder-joint are common and occur with and without a definite traumatic history. In a series of 579 cases treated in a fracture clinic there were 42 injuries of the shoulder-joint (7·2%). Of these 27 were fractures and seven dislocations. In many cases of shoulder disability, however, the traumatic history is old or slight, or may be entirely absent.

Any trauma of the shoulder may be followed by disability, usually limitation of movement, particularly in old patients or following inadequate treatment. This condition of traumatic stiff shoulder is, however, no commoner than the disability due to lesions of the supraspinatus. Codman states that rupture of the supraspinatus tendon is the most common industrial injury causing prolonged shoulder disability. Partial tears of this muscle have been found in 17% of cadavera (Keyes), and the proportion may be higher in older subjects of the working-class. As the supraspinatus suffers from other lesions as well as tears, it is important to consider how this muscle comes to be so subject to trauma.

Anatomical considerations.—(1) The shoulder-joint depends for its stability upon the strength of the muscles surrounding it. Of these the supraspinatus is one of the weakest.

(2) In man's ascent to the upright posture the supraspinatus has had to change its action from swinging the foreleg to lifting the arm against gravity.

(3) The supraspinatus is attached comparatively close to the fulcrum of a long lever, so that blows upon the elbow, for example, may throw a great strain upon the muscle.

(4) The tendon of the supraspinatus moves in a narrow gap between the head of the humerus below and the acromion above, and it can easily be pinched between these two structures.

The supraspinatus is, therefore, liable to both strains and bruises, and it is possible that the latter have been too much neglected in considering the ætiology of lesions

of the tendon. The chief lesions which are found in the tendon are partial ruptures—and complete—degenerative changes, and calcified deposits.

Causation.—Tears of the tendon are caused by a sudden strain falling on the abducted arm, as in trying to save oneself from falling sideways. But whereas considerable force is required to rupture the healthy tendon, very slight trauma will produce this result when degenerative changes have occurred. There is evidence to show that considerable friction and bruising of the muscle occur in those who perform much overhead work, such as plasterers and painters, and that after some years degenerative changes, such as fraying, occur in the tendon. Ruptures of the muscle are more common, therefore, in the middle-aged and old, and in certain classes of worker.

Calcareous deposits, however, do not seem to be more common in these occupations, and possibly follow a single injury. This may be a bruise of the muscle with effusion of blood, a tear of some fibres of the tendon, or partial avulsion of its insertion. The effused blood is gradually turned into a calcareous mass, of cheesy or creamy consistency, lying under the floor of the subdeltoid bursa, or in the substance of the tendon.

The symptoms and signs of rupture of the tendon are fairly typical. There is pain in the shoulder, sometimes referred to the insertion of the deltoid. Internal rotation is limited and painful. Active abduction of the arm is difficult or impossible, while passive abduction is full and usually almost painless. There is interference with the scapulo-humeral rhythm, and movement through the arc from 70° to 90° abduction is very painful. In addition there is a tender spot above the greater tuberosity of the humerus. Patients with partial ruptures of the tendon almost always recover their function, and lose their symptoms, but this recovery may take up to six months. Complete tears, on the other hand, leave a permanent disability.

Treatment of ruptured supraspinatus tendon.—The great difficulty in treatment is to differentiate between complete and partial tears. If the trauma has been severe, or if after a fairly long period of pain in the shoulder a slight injury results in severe pain with complete inability to abduct the arm actively, the tear is probably complete. In these cases there is an effusion of fluid into the shoulder-joint and sub-deltoid bursa. After the rupture, of course, these two cavities communicate. It might be possible in such cases to clinch the diagnosis by aspirating blood-stained fluid. As complete ruptures do not heal and lead to a permanent disability which may be severe or may prevent the patient's working, operation should be undertaken.

Details of operation.—A vertical incision is made from the acromion along the anterior border of the deltoid. The muscle-fibres are split near this border and the roof of the sub-deltoid bursa is exposed. This is incised and rotation of the arm will bring the insertion of the supraspinatus into view. If there is a complete rupture of the tendon its proximal end may have retracted an inch or more exposing the head of the humerus. Sutures of the tendon may involve boring two holes in the greater tuberosity if the distal tag is insufficiently large. If the suture is cut out of the proximal end, the gap may be closed by sewing the tendon of the infraspinatus to that of the subscapularis. Two or three catgut sutures close the split deltoid.

After-treatment consists of early passive and assisted active moevments in the interval, supporting the arm in moderate abduction on a pillow. The results are good, but the treatment may have to be continued for several weeks.

The treatment of partial ruptures is far less satisfactory, although recovery always occurs in time. Heat relieves the pain and the arm should be kept in a sling. Active abduction, except with assistance, is avoided. Gentle and progressive movements improve the condition, and after the acute stage faradism to the supraspinatus is

helpful. Sometimes movements of the shoulder become limited, but manipulation should not be undertaken until there is no local tenderness and the patient can sleep lying on the affected shoulder. Too early manipulation causes marked spasm, increase of pain, and interferes with the restoration of movement. If the recovery has not taken place within six months, the diagnosis was probably incorrect, or the tear was a complete one.

Calcified deposits were first described by Painter in 1907, and since that time many articles have appeared on the subject—mostly in the American journals, but Elmslie has also written an excellent account of several cases.

They occur in the supraspinatus tendon (as a rule) and near its insertion. In an anteroposterior skiagram, with the arm in external rotation, the deposits may usually be seen lying just above the greater tuberosity of the humerus. They may exist for a long time without causing symptoms. After they have caused acute symptoms they may disappear rapidly and spontaneously, but the symptoms often continue or recur.

The usual history is that some time after a moderate trauma the shoulder is painful and has to be treated with care ; subsequently, and occasionally without further injury, it becomes acutely painful, often necessitating opiates. Movement is much limited by spasm, and X-ray examination reveals the lesion. The signs are similar to those of a partially ruptured tendon. McMurray states that rest with the arm in abduction for three or four weeks usually leads to disappearance of the deposit. The position is uncomfortable to maintain and the pain may be very severe.

Operation is more satisfactory in severe cases, as it results in immediate relief which is permanent. The tendon is exposed as already described. Sometimes the whitish deposit can be seen through the thin floor of the bursa ; sometimes it is hidden in the tendon substance. Occasionally the creamy fluid is under great tension, which explains the acute pain sometimes met with. The deposit may be removed with a curette, or excised with the knife. Sometimes a cavity is found in the bone at the attachment of the tendon. Spontaneous disappearance of the deposit may occur by absorption, but sometimes occurs owing to the cyst bursting into the sub-deltoid bursa.

A parallel case to this occurred in the case of a deposit in the tendon of the gluteus medius. The patient felt something burst and the pain disappeared. X-rays confirmed the dispersion of the calcified material.

Statistics.—I have observed 22 cases of supraspinatus lesions, as follows : Three complete tears proved by operation—one not operated ; not recovered. Fifteen partial tears, 10 of which were followed to recovery. Three calcified deposits.

Mr. B. H. BURNS said: With reference to the treatment of calcareous deposits in the supraspinatus tendon, I have been extremely pleased with two cases that I have lately treated by irrigation.

Briefly, the technique is as follows: Novocain is injected into the skin, two wheals being raised, one over the point of maximum tenderness, another at a point about an inch posterior to this. A needle is introduced through each of these wheals, aiming at the tender spot over the calcareous deposit in the supraspinatus tendon. When bone is reached both needles are withdrawn for an eighth of an inch and then their points should be in contact. Through one needle saline solution is introduced under pressure. The calcareous material, which looks like zinc ointment, mixed with the saline, will escape from the other needle which should be of a larger bore. The relief of pain is immediate and permanent.

There is a full description of this method of treatment in an article by Patterson and Darrach of New York in the *Journal of Bone and Joint Surgery*, 1937, **19**, 993.

The Lorenz Bifurcation Osteotomy for Irreducible Congenital Dislocation of Hip

M. F. Forrester-Brown, M.S.

The audience at this meeting may, I fear, be divided into two groups: (1) Those who saw Lorenz's original film of his bifurcation osteotomy and were convinced of the value of the method; (2) those who consider an unreduced congenital dislocation of the hip in a patient over 7 years of age unsuitable for any surgical procedure.

There may possibly be a further group, namely, those who consider that at any age it is right to attempt reduction by open dissection, but these may be open to the suggestion that if such an operation has failed to give good function, some further procedure should be tried. It is not my purpose here to discuss the merits of open reduction for dislocations at various ages, but it may be legitimate to remind surgeons that:—

(1) If no manipulation has been attempted before the ages of 5–7 years, organic changes will have occurred in all the tissues of the joint and offer serious obstacles to reduction and its maintenance, even by open operation.

(2) If manipulation has failed in a patient under the age of 4 years, there is almost certainly some mechanical obstacle interfering with reduction, as is well demonstrated in Putti's recent "Atlas" and though some of these obstacles may be amenable to operation, others may render the joint permanently unstable.

(3) Any joint in which the articular surfaces are incongruous is liable to early arthritic changes, and this possibility is not excluded even by open reduction. Such an arthritis ultimately produces flexion contracture of the hip with secondary lordosis, which is itself one of the common complications of unreduced dislocation.

(4) The most successful open reduction does not abolish the anteversion of the femoral neck, often necessitating a further operation, i.e. a rotation osteotomy of the shaft of the femur. It should, therefore, be considered whether one osteotomy, which gives such correction and stability as well to the hip, is not the better procedure.

It next remains to consider the disabilities of unreduced hip dislocation, for which the patient consults the surgeon. They are chiefly:—Muscular insufficiency, due to lack of a fulcrum, as is well demonstrated in the Trendelenburg gait. Shortening, which may be partly due to lagging growth of all the tissues of a limb, but is chiefly caused by upward displacement of the femur; this cannot be masked by abducting the limb because the abductor muscles have no fulcrum to work on. Lordosis associated with secondary strain on the spinal joints is most marked in posterio-dislocations and may be inconspicuous in anterior ones. It is often due not only to the instability of the pelvis on the femoral head, but also to actual shortening of the hip-flexors. Provided hyperextension is induced in the lower fragment (shaft) at the osteotomy, this feature is abolished. External rotation of the hip resulting in outward pointing of the foot and knee and secondary strains of the ligaments of the foot and knee, is due to the lack of a fulcrum for the rotation muscles and can be corrected by an osteotomy.

Arthritis is liable to occur in the unreduced dislocation, apart from the trauma of attempts at reduction, and it is not uncommon in fairly stable anterior subluxations. For arthritis—due to causes other than dislocation—a bifurcation osteotomy has been found useful—altering the directions of stress and correcting the hip flexion and lordosis—so that it is doubly indicated in the congenital type, in which it simultaneously abolishes the instability.

To sum up: A bifurcation osteotomy efficiently carried out provides a fulcrum for

the hip muscles as they run their abnormal course, thereby abolishing the ugly waddle. Furthermore it enables any true shortening to be masked, it gets rid of the out-pointing foot and the lordosis, and, finally, it reduces strain on the incongruous articular cartilages, thus minimizing the tendency to arthritis, or reducing symptoms if arthritis has already occurred.

Technique

The idea of the Lorenz osteotomy is to convert the abnormal upper end of the dislocated femur into a fork at the top of the shaft or, more usually, into an inverted L, of which the angle rests in the true acetabulum, while the tip of the short limb remains in or near the false acetabulum in the region of the anterior inferior spine, and the long limb is represented by the femoral shaft.

There are quite a number of ways of producing this L, but it seems to me that Lorenz's own technique as demonstrated in his original film, which was shown at the Dutch Orthopædic Association Meeting in 1921, has many advantages.

A common form of the operation is the sub-trochanteric osteotomy, in which the lower fragment (upper end of the shaft) is forced upward on the upper fragment to lie in the bottom of the true acetabulum. This results in increasing the true shortening of the limb and bringing two pieces of dense cortex in contact, which delays bony union ; it is also liable to be followed by permanent fixation in abduction of the limb. An inter-trochanteric osteotomy in the sagittal plane has the same drawbacks, while the upper fragment with the atrophied head is liable to be so small as to be uncontrollable.

The Lorenz principle, which I have been using since the original demonstration, is to make an inter-trochanteric osteotomy in the coronal plane—the frontal plane—of the body, so that when the upper end of the shaft is guided into the true acetabulum its raw posterior surface continues in contact with the raw anterior surface of the upper fragment ; this prevents it from slipping backwards and makes hyperextension of the limb easy and also induces early bone union. After union has occurred, the abduction of the shaft can be reduced and as the limb comes in it pulls the head with it, bringing the whole bone to a somewhat lower level, which is sometimes enough to compensate for the inevitable shortening of the osteotomy. The shortening, however, is rarely more than ½ in., never more than 3 or 4 in., and in young subjects it may be abolished by extra growth following the improved function of the limb with extra weight-bearing.

(1) Skin incision : I prefer a curved incision, convex downwards, below the base of the great trochanter. The skin-flap can be dissected up with hardly any bleeding and retracts itself with a Lane's forceps.

(2) Incision of muscle and periosteum vertically down for several inches from the apex of the great trochanter to the level of the small trochanter ; the periosteum is freed by sharp elevators round the femur, as far as possible, and protected by blunt elevators during the division of the bone, so that it can be sewn up at the end and help to prevent separation of the bone fragments.

(3) Making a track into the true acetabulum : This is done by blunt dissection along the femoral neck before the bone is divided, so that no bleeding occurs and the relations of the parts have not been disturbed. One keeps behind the femoral vessels and down behind the lower edge of the dislocated neck. Often the acetabulum is very small, but sufficient space must be made in it and to it by the finger, so that the pointed end of the shaft will pass easily.

(4) The line of osteotomy, as already explained, passes from the top of the

great trochanter downward and inward, to the region of the small trochanter, with the blade of the osteotome held in the frontal plane. The bone must be cut clean, not broken green-stick fashion, otherwise the end of the shaft will not be free enough for it to pass into the acetabulum.

(5) Manipulation of fragments: The top of the shaft is next guided along the track already made into the true acetabulum. The tension of the periosteum tends to angulate the upper fragment on it with adduction of its lower end, thus producing the desired L. Even if the upper fragment refuses to adduct much, adduction can be brought about at a subsequent manipulation when callus has tied both ends together. It is unnecessary to waste time over this at the operation, provided the shaft has been well abducted, extended backwards, and rotated so as to bring the knee into the normal relation with the body axis.

(6) Suture of periosteum, with deep layer of muscle origins, by interrupted catgut, and over this the superficial sheath of the tensor fasciæ femoris. If this is done firmly with No. 2 catgut, the bone is rendered fairly stable, and the skin is sutured loosely to allow for escape of blood.

(7) A firm spica bandage is applied to force the region of the great trochanter against the pelvis.

The limb is fastened to a hip-abduction frame in wide abduction, slight internal rotation, and full extension. Skin traction has been put on before operation but is not tied very tightly, as one does not want to pull the fragments apart, only to steady the limb.

It is a wise precaution to put these patients on the hip-frame with hips flexed and back flat, for ten days before the operation, so as to abolish any lumbar spasm.

After-treatment

It is essential to fix the limb in wide abduction till callus unites the bone ends, otherwise the shaft might slip out of the acetabulum. I find that is effectively done on a double hip-abduction frame; my own type has several advantages over the Jones frame. It only lengthens the time under an anæsthetic to apply a plaster spica at the end of the operation, and even if this is done, a second one should be applied later, as it is impossible to get perfect alignment until the fragments are steadied by callus.

It has been found useful, and likely to reduce shock, to perform the operation itself on the frame, the leg on the affected side being left free for manipulation while that on the sound side is fixed ready by traction, which reduces the time considerably at the end of the operation.

The stitches are left in for at least two weeks, so as not to disturb the splinting effect of the firm bandage. After the dressing has been changed an X-ray examination is made on the frame, to control the exact position of the fragments and show whether callus is forming. If it is abundant, re-moulding is carried out three weeks from the date of the operation; if it is scanty this is postponed.

Re-moulding under anæsthesia after soft callus has anchored the bone ends produces the best possible results. It is then possible to control the axis of the foot accurately—so that it points forward, not outward—also to reduce excessive abduction. I have found that if the limb is abducted to an angle equal to the maximum abduction possible on the sound side, the ultimate range of the hip is likely to allow adduction to neutral, which gives the best gait. The limb should not be fixed in permanent actual abduction but only in relative abduction of the shaft on the neck. Otherwise the gait will be stiff and awkward. It is possible to get a good result with an osteotomy

on each side for double dislocation, which would not be the case if the limbs had to be fixed in permanent abduction.

Another important point is to hyperextend the hip by bringing the knee behind the body axis. It is almost impossible to overdo this, as so often there is latent lordosis, even when one thinks one has the back straight.

Only one hip need be included in the spica, provided it is well moulded on the pelvis and carried up the chest to fix the lumbar spine.

The patient can be active in bed for six weeks so that the sound limb is in a position to stand weight-bearing when he first gets up. If the osteotomy seems to be united on manipulation, six weeks in plaster is sufficient. If the fragments feel rather loose then three months should be given. In any case as soon as the plaster is bi-valved, a skiagram should be taken to make sure that union is solid. The line of osteotomy is hard to make out with coronal section but union is always rapid.

As soon as one is sure that there is no likelihood of bending, massage and active exercises are given. First, extension and abduction, later flexion and adduction without weight-bearing. It is best for the patient to begin walking in the deep pool so that no leverage occurs on the bone, and adduction is induced by swimming exercises. Once the patient has obtained his balance, walking is begun between parallel bars. No attempt is made to hasten adduction. The limb usually has apparent lengthening, and occasionally it is necessary to put a "raise"—half an inch to an inch—on the heel of the sound side. Until the limb comes into neutral, walking is clumsy, so parents must be warned that the final good result may not be visible for nearly six months. Any attempts to hasten it might bend the callus and result in instability. On the other hand, the angle of change produced by the operation need not be so great as many people think, and cases are quite stable in which the L position is not obvious on the final skiagram till this is compared with the original one. I have found that if the shaft is carried outward 30°, as compared with its original line, the best result is obtained. One noticeable feature is the way in which, after the final moulding, the head and neck are dragged downward towards the true acetabulum by the altered alignment as the limb comes back into adduction—the reverse of what originally happened, when an unstable reduction of the hip allowed re-dislocation as soon as the limb was adducted.

Results

The results of such an operation do not lend themselves to statistical analysis, since it was performed to relieve functional disability and the assessment of function always has a personal element on both the patient's and the surgeon's side. I may say that in every case in which I have carried out this operation the parents are convinced that the child's gait has improved enormously.

Stability.—The Trendelenburg position has been abolished in all cases, therefore one may hope that the liability to arthritis will have been correspondingly reduced.

Mobility.—In all cases very useful movement remains in the hip, that is to say, there is wide abduction—equal, or nearly equal, to that on the sound side—internal rotation, usually well beyond neutral, and flexion to a right angle, usually much beyond, sometimes equal to that on the normal side. On the other hand, adduction and internal rotation are abolished. Extension is free and the lordosis is eliminated. In two cases in which open operation had been performed previously elsewhere, there was considerable stiffness of the joint from early arthritis and though the osteotomy masked the shortening, it has not—at least as yet—restored joint-movement.

Muscle tone.—The re-development of the hip muscles, as with other congenital defects, has varied with the severity of the case, that is the extent to which the condition is a primary one of non-development of all the tissues of the region. Naturally, in cases in which the operation was carried out early there was less atrophy than in those in which the patients had been allowed to go for years with a faulty balance. On the other hand, one or two young patients seemed to have an associated congenital amyotonia in the muscles of the sound side and trunk and this delayed the return of ability to walk without a limp. In another case, in which an open reduction had been unsuccessfully attempted before it came under my care, there seemed to be paralysis with extreme atrophy of all the gluteal muscles, possibly associated with the making

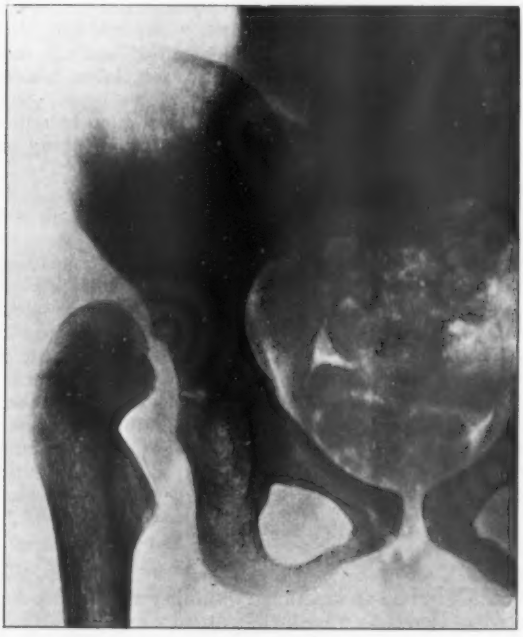


FIG. 1*a*.—I. W. 20.1.36. Before operation.

of a long incision through the buttock. Naturally, the earliest return of good walking after the operation was obtained in those patients whose muscles were elastic and already well developed.

Although in this paper I have been dealing with congenital dislocations, I may mention that very satisfactory results have been obtained in cases of dislocation after old tuberculosis or septic arthritis in infancy. Here the range of movement may not be so complete but it has tended to increase after the operation, in useful directions—not to diminish, as might have been feared.

In all these cases the operation can be strongly recommended, as a means of improving function for a type of patient whose gait is ugly, even when not painful,

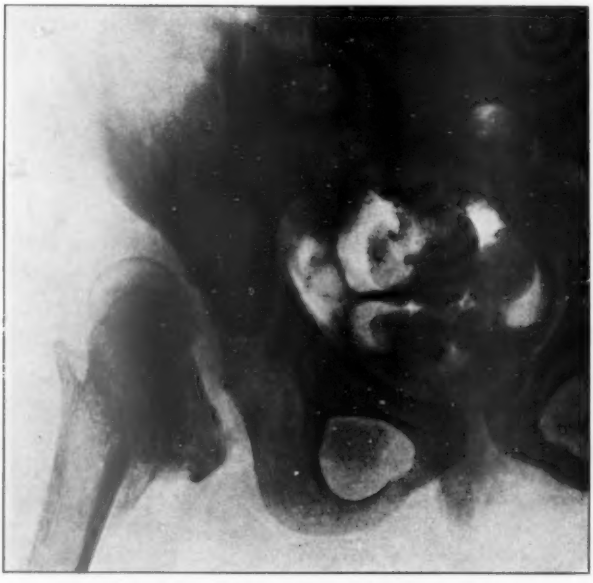


FIG. 1*b*.—I. W. 27.3.36. **Three weeks after osteotomy.**

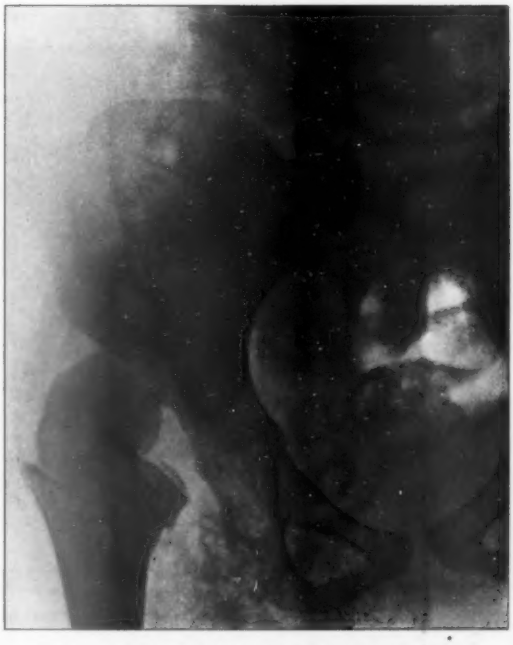


FIG. 1*c*.—I. W. 5.8.36. **Five months after operation.**

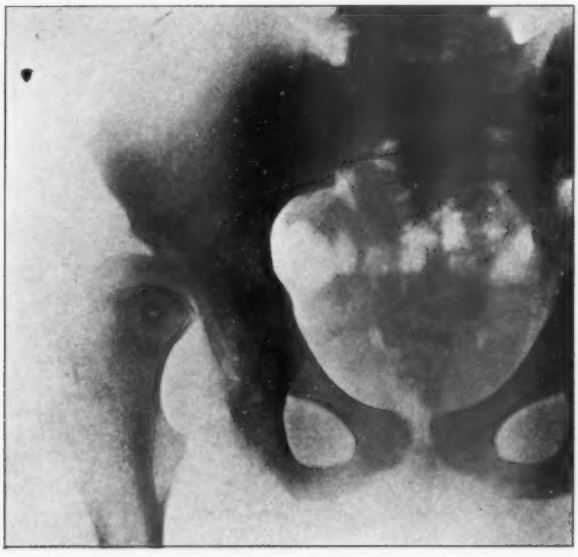


FIG. 2*a*.—D. W. 6.2.33. Before operation.

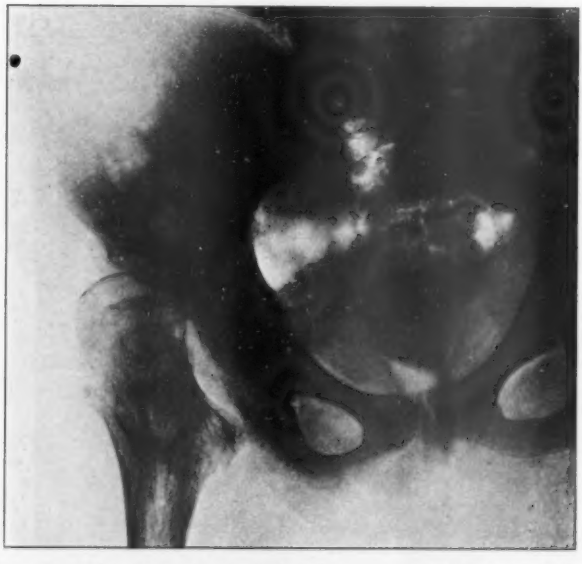


FIG. 2*b*.—D. W. 15.5.33. Nine weeks after operation, when first walking.

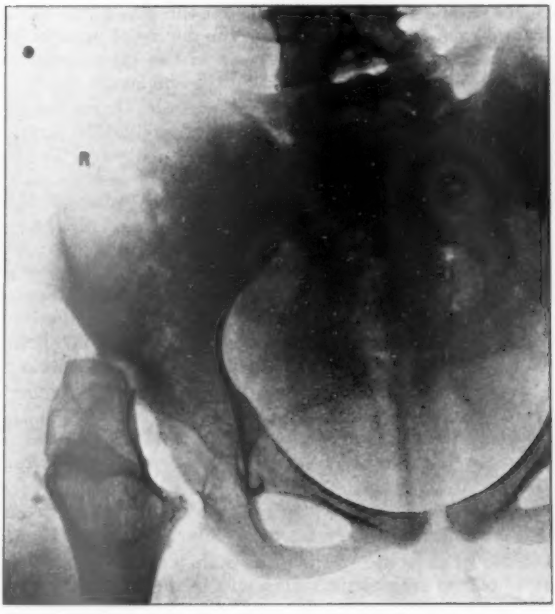


FIG. 2*c*.—D. W. 14.10.35. Two and a half years after operation.

and who tends to get slowly worse, while increase in height and weight puts more leverage on the weak parts and age brings its burden of strain and rheumatism.

A Method of Grafting Long Bones

By T. T. STAMM, F.R.C.S.

THE case of the ununited fracture presents two separate problems, for it is necessary to consider not only the restoration of function to the affected limb, but also the time factor. Any method which offers a chance of producing eventual union of the fracture without undue shortening may be satisfactory from the point of view of eventual function. In these cases, however, the patient has already been incapacitated for a long period, during which treatment has been ineffective. He has reached a stage when he has some right to demand that any further efforts to produce union should be as far as possible certain of success and should produce that result in the shortest possible time. Although he may be a new patient to the surgeon concerned, he is certainly a very old patient to himself. Conservative methods, such as drilling of the bone ends, or further prolonged immobilization, are often economically unsound, as they are not certain to succeed and may merely result in a further increase in the period of incapacity.

Treatment by bone-grafting offers a solution to the problem only in so far a it is certain of success, and that in a reasonably short time. Although all methods of bone-grafting may succeed in some cases, it will, I think, be agreed that a high per-

centage of successful results depends primarily on the size of the area of apposition between the graft and each fragment and upon the degree of immobilization obtained between these surfaces. The larger the graft and the more secure its fixation to both fragments, the more certain is the procedure to be successful.

There is no doubt that a large intramedullary graft, hammered in until it has jammed tight, offers the best chance of securing rigid fixation, and experience has shown the method to be sound, in spite of the theoretical objection to filling up the intramedullary cavity. Moreover, the intramedullary method can be applied to almost any bone. It has, however, one serious disadvantage. Although a graft can nearly always be fixed into one fragment by the intramedullary method, sufficient distraction at the site of the fracture cannot usually be obtained to allow a reasonable length of graft to be inserted into the second fragment, unless length of the limb is unduly sacrificed. I feel therefore that any modification in technique which will help to overcome this difficulty is worth recording. The method to be described is a modification of the double intramedullary peg technique, which permits a sufficient length of graft to be inserted into both fragments to ensure absolute rigidity.

The site of the fracture and two to three inches of both fragments are exposed and freed from the surrounding tissues. A sufficient amount of the end of each fragment is then sawn off so that the cut end shows normal texture. The medullary cavities are then roughly cleared out to a depth of about three inches.

A sufficient length of the shaft of one fibula is then removed subperiosteally to form the graft. Practically the whole length of the shaft may be taken if it is desired to fill a long gap. The fibula regenerates in a remarkably short time.

About three inches of each end of the graft is then shaped until it will just fit into the respective ends of the fragments. One end is then inserted into the fragment

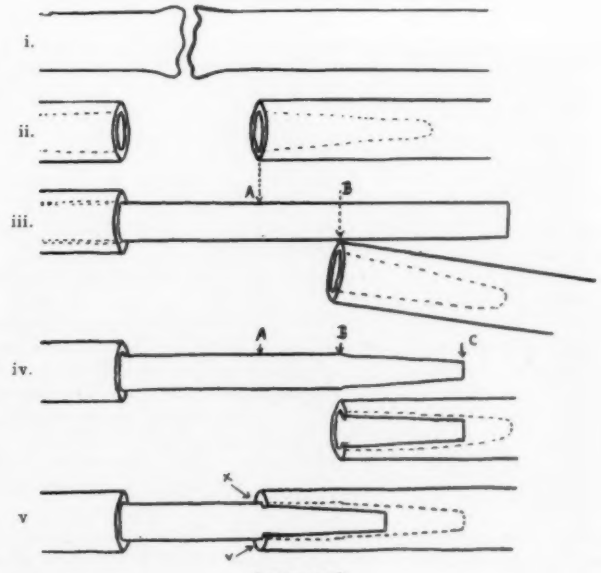
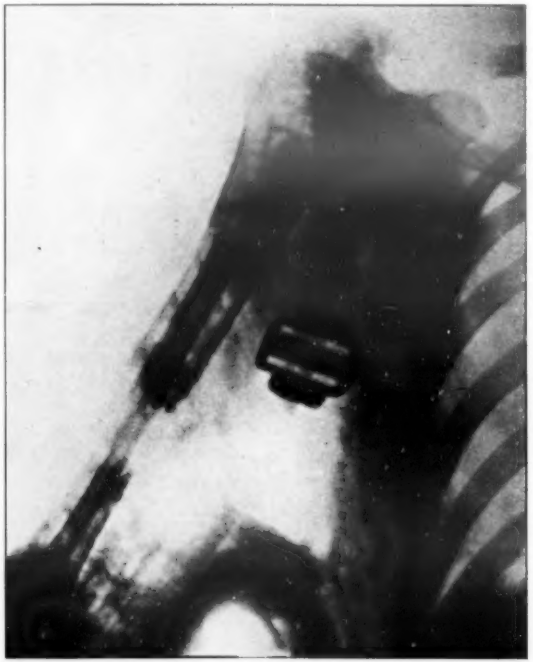


Diagram I.

PROC. ROY. SOC. MED.
Vol. XXXI, No. 5.
Section of Orthopædics.

PLATE I.



6.4.37.

FIG. 1 showing the method applied to a case of ununited fracture of the humerus.

31.8.37.

FIG. 2 illustrating the result five and a half months later.

PLATE II.

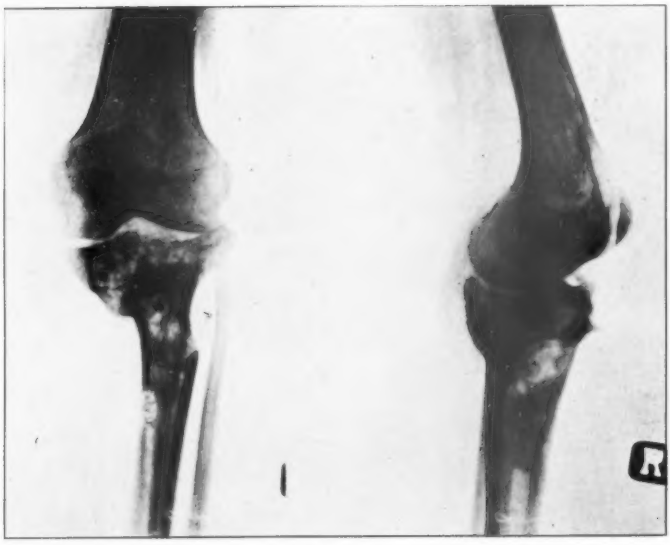
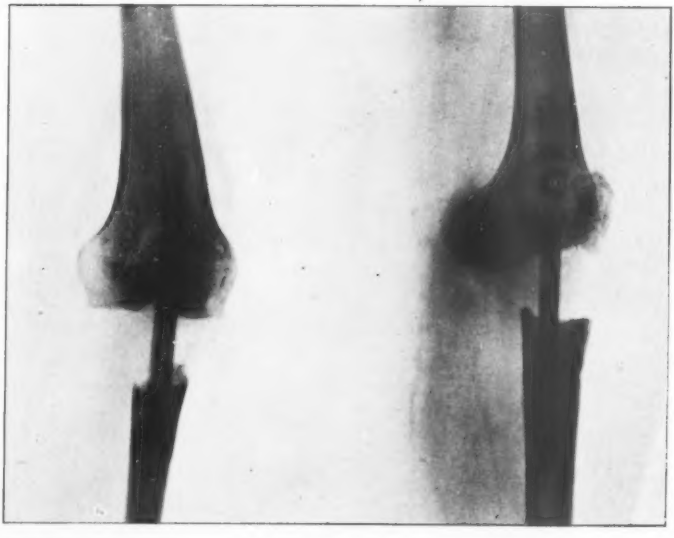


FIG. 3.



1.12.37.

FIG. 4.

FIGS. 3 and 4 illustrating the application of the method to a case of recurring giant-celled tumour which had involved the knee-joint. The fibula was able to be inserted into both tibia and femur to a considerable depth without sacrificing more than ½ in. in the length of the limb, after a block resection of the growth and the joint had been performed.

T. T. STAMM : A Method of Grafting Long Bones.

where fixation is the most difficult, and is hammered home until it has jammed tight. The two fragments are then distracted as far as possible. The point B in fig. iii, Diagram I, is then marked on the graft. The distance A–B represents the amount of distraction possible, and therefore the length of graft which could be inserted into the second fragment without producing shortening of the limb. This is almost invariably too short, even in the " single bone " segments of the limbs.

A slot is now cut in the second fragment (fig. iv). This slot was originally made with parallel sides, but it has been found better to make the slot slightly V-shaped as shown in the diagram. The end of the graft from the point B is then cut down so that it will just pass through the slot.

The fragments are now again distracted to the maximum, when the portion of the graft B–C can be dropped through the slot into the medullary cavity. The graft is now forced up the medullary cavity as far as the point A. By this procedure at least double the length of graft can be inserted into the second fragment and rigid fixation thus ensured at both ends. In cases where a very small amount of distraction is possible, even $\frac{1}{4}$ in. of impaction may suffice to ensure fixation.

Certain points in connexion with technique should be mentioned :—

As the whole shaft of the fibula is used, the graft is far stronger than the ordinary cortical graft from the tibia, and large gaps can therefore be safely bridged. This permits the bone ends to be widely excised in cases where they have become either atrophied or sclerosed. At the same time no sacrifice need be made in the length of the bone as it is quite unnecessary to bring the bone ends together.

Where the fracture is close to one end of the bone, fixation into the short fragment is always difficult. This end should therefore be fixed first and advantage may be taken of the variations in the shape of different parts of the shaft of the fibula.

Diagram II shows how this fact may help in securing fixation into a short lower humeral fragment, where the medullary cavity is narrow in the centre but wider at the sides where it passes into the two condyles. The fibula in its upper part is so

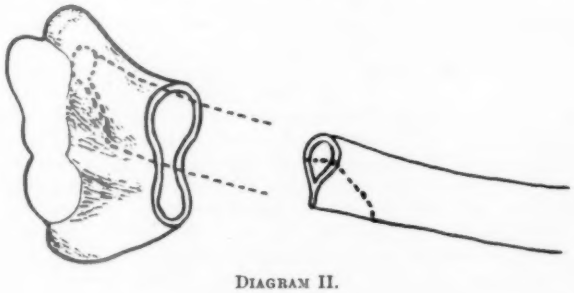


DIAGRAM II.

shaped that the main portion of the shaft will pass into the condyle, while the thin interosseous crest will fit into the central portion of the medullary cavity.

If the medullary cavities are not completely cleared out, the remaining cancellous bone is compressed and moulded by the graft as it is forced in, and greatly assists in ensuring a tight fit without the need for great accuracy in carpentry.

It is better to cut the slot and the end of the graft into a slight taper, rather than making the sides parallel, for two reasons : (1) If the sides are parallel there will be a weak spot in the graft at the point B (Diagram I), and the distal end will be liable

to snap off. (2) The slight taper on the graft causes the cancellous bone in the medullary cavity to be compressed to the sides instead of being forced along in front of the graft. The junction therefore tightens up gradually, and the graft does not suddenly " jam ", perhaps before it is in far enough.

As the second end of the graft is partly cut down in width, the corresponding medullary cavity should not be cleared out quite so much.

The graft at the point A (Diagram I) and the corresponding hole in the intramedullary cavity must be slightly larger than the slot at this point, so that two shoulders are left as shown in fig. v at X and Y, which will overlap the graft and ensure that no angulation can occur. Also the graft should be orientated so that a flat surface faces the slot and thus fits properly under the two shoulders.

Section of Surgery

President—G. GREY TURNER, M.S.

[*December* 1, 1937]

DISCUSSION ON THE TREATMENT OF PERFORATED PEPTIC ULCER

Mr. V. Z. Cope: Till forty-five years ago the perforation of a peptic ulcer was usually a fatal occurrence. The first successful case of suture of such an ulcer was carried out by v. Heusner in 1892, and in the following year Hastings Gilford and Morse had successful cases in this country. From that time onwards recovery from the condition has been common, though operative technique has altered from time to time.

The first operations consisted of closure of the opening by sutures of the Lembert type; usually two rows were inserted. The peritoneal cavity was thoroughly washed out by many quarts of warm water or mild antiseptic lotion, and drainage was attempted by rubber or glass tubes put down to the pelvis, to the site of the ulcer, and sometimes to the loins. Washing out the peritoneal cavity was soon found to be unnecessary, and drainage down to the ulcer-site inadvisable. Drainage of the pelvis with the patient in the Fowler position has survived to the present time, though most would agree that if the case were operated on within twelve hours after perforation there would be no real need for any abdominal drainage.

In 1896 Bennett suggested that in those cases of large perforation which were very difficult to suture it would be possible to obtain success by pushing a plug of omentum into the opening and suturing this in position by Lembert sutures. This method has been found useful by some surgeons.

In 1901 Moynihan reviewed the literature of perforated duodenal ulcer and mentioned that in the first case on which he operated for such a lesion he had considered the duodenal canal so narrowed by the suturing that he had felt compelled to perform gastro-jejunostomy, and he remarked that this procedure might from time to time be necessary. Later Paterson contended that the routine performance of gastro-jejunostomy would diminish the immediate mortality by encouraging peristalsis and consequently helping absorption of the peritoneal exudate; he also contended that it would prevent leakage from the suture line, make hæmorrhage from the ulcer less likely and, by relief of tension, prevent perforation of any second ulcer. Quite a number of surgeons followed this teaching and practice and some good results were published, but with most surgeons this is still only an occasional technique. Guthrie, in reply to a questionnaire, found that 24 surgeons performed gastro-enterostomy as a routine, 64 never performed it, and 63 occasionally found it advisable.

In 1909 Dowden recommended excision of the ulcer and the performance of pyloroplasty for ulcers near the pylorus. This operation has never been popular, though Moynihan carried it out 21 times with only one death.

In 1902 Keetley had to deal with a large perforation near the pylorus for which he thought fit to perform pylorectomy; though it was successful few surgeons practised this operation till recent years. After the War Finsterer's recommendation of

partial gastrectomy for both duodenal and gastric ulcers was adopted by many surgeons on the Continent, and the practice has become increasingly popular among the enterprising surgeons in this country and in America. It was therefore no surprise that some should try partial gastrectomy in certain cases of perforated ulcer.

At first it was only tried in cases coming to operation soon after perforation, but gradually it was found that successful results might be obtained even when the peritoneum was seriously infected, and now we are faced with the fact that in some clinics two-thirds or three-quarters of the cases of perforated ulcer are treated by partial gastrectomy. Judine, who is a prominent exponent of this method of treatment, points out that before carrying out this operation one must carefully consider the age and general condition of the patient, the amount of peritoneal infection, the number of hours which have elapsed since perforation, and the experience of the operator; he lays stress on the fact that better results are obtained by the use of local and splanchnic anæsthesia.

Faced with these divergent views, we must decide partly on general principles and partly on the published results of the various methods. Results published in the early days are not easily comparable with those of recent years, for the type of case has altered. The majority of perforated ulcers forty years ago occurred in the stomachs of young anæmic girls. Among the first 50 cases of perforated ulcer at St. George's Hospital there were 42 gastric cases of which 33 were women. Of the first 27 cases of perforated ulcer on which Moynihan operated, and the account of which was published in 1907, 14 were cases of perforated gastric ulcer in women. Gradually the proportion has altered. In 1913 Morley published 112 cases which had occurred at the Manchester Royal Infirmary, and of these only 30 were in women. Since the Great War there has been a great proportionate increase in duodenal perforations in men. In Russia Judine has recorded over 550 cases of which only seven were in women. Mervyn Stewart from Melbourne recorded 257 cases, of which only 13 were women. Some figures from America, such as those of Gibson, do not show this disproportion, but, generally speaking, perforation of the stomach in young women is now rare; this type was, I believe, more fatal than the common duodenal perforation.

Before comparing statistics one must know the time which has elapsed between perforation and operation in all the series. It is well known that after the expiration of twelve hours the mortality-risk of a free perforation into the main peritoneal cavity rapidly increases. Those surgeons who are fortunate enough to get their cases sent into hospital soon after perforation will have better figures. The great discrepancy in the figures from different clinics is very surprising, and furnishes an indication of the efficiency both of the general practitioner and of the transport services of the cities in which those clinics are situated. Some statistical lists deal with a younger set of patients. Mervyn Stewart has shown that the mortality of perforated ulcer is much greater after the age of 50 than before, so we shall not be surprised to find that lists containing a larger proportion of older patients have a higher mortality rate.

It must also be borne in mind that those who perform more extensive operations will reserve the simpler and quicker methods for those late cases which would not stand the major operation; this penalizes the simpler technique.

In considering statistics one must carefully distinguish between the operative mortality and the total mortality. Some lists exclude cases which are too ill for operation to be undertaken. In order to form a just estimate of the true mortality from perforated ulcer all cases received into the clinic should be included. The total mortality thus obtained gives a true picture of the efficiency of the medical services of the district served by that hospital. If late cases are excluded the picture is distorted.

It would be difficult to expect better results than the best of the published results of simple suture. Gilmour reported a series of 64 cases, of which 63 were treated by simple suture and one by suture and gastro-jejunostomy. The mortality rate in

cases operated on under twelve hours was 0·5%, and in cases over twelve hours 15%. The total mortality was 4·7%. The author with justice comments " we are of opinion that these low figures fully justify the use of simple suture as the routine treatment of acute perforated ulcer ". Almost equally good were the figures of Southam, who lost no case out of 34 cases of duodenal perforations which came under his care within twenty-four hours of rupture ; his mortality for both early and late cases was only 9%. These figures are, I believe, better than the average. I have studied many published lists which vary greatly from one another. Probably an average list is that of Zakschwerdt and Eck who, in a series of 112 cases, had a mortality of 17·3 for those cases operated on within twelve hours, and a mortality of 36·7% for all cases operated upon.

The results when gastro-jejunostomy is also performed as a routine can be judged from the figures from Krosnizeff's clinic. Here the total mortality was 24·3%, and for those cases seen within twelve hours it was 15%.

The figures giving the results of partial gastrectomy for perforated ulcer are difficult to evaluate, and in some cases somewhat difficult to credit. Kunz collected 528 cases of resection for perforated ulcer and found the mortality 16·5% ; if however we take only those cases operated on under twelve hours the mortality was only 9·1%. Far the best figures for resection are those published by Judine, who records 317 cases with 27 deaths ; most of these were operated on within twelve hours and most were under 50 years of age.

I find it difficult to draw definite conclusions from my study of statistics, but the judgment is helped by considering the advantages and disadvantages of the various procedures.

Simple suture is an operation which can be carried out by anyone possessing even a moderate experience of abdominal surgery and can be performed speedily and with little shock to the patient. The very good results published by many surgeons furnish the best proof that no appreciable stenosis of the duodenum is caused by the suturing. It has been shown by many observers that in a considerable number of cases no further gastric symptoms are suffered after the perforation has been closed in this way. On the principle that with a dangerously ill patient the saving of life by the least interference is the best policy, simple suture must have many adherents.

Those who advocate the performance of gastro-jejunostomy at the time of suture of the ulcer maintain that the time taken for its performance is not much longer and is counterbalanced by the advantage gained, namely that the ulcer is relieved from tension and is less likely to bleed, while the patient can be fed earlier. At the same time the anastomosis may bring about a cure of a chronic ulcer. They say little about the probability that some of the ulcers may be acute, nor do they reckon with the possibility that a number of gastro-jejunal ulcers may develop.

Those who advocate partial gastrectomy for perforated ulcers whenever possible make several assumptions, which are necessary to justify their position. They assume that after simple suture serious narrowing of the duodenum is inevitable, and they take it as proved that all ulcers which perforate are chronic ulcers in need of radical treatment. Granted these two premises, and given that partial gastrectomy is the correct treatment for a chronic ulcer, it is clear that a skilful surgeon operating upon a patient in fairly good condition may bring about a successful result. But these premises and provisos are by no means established. If, as on good authority we may believe, from 15 to 20% of ulcers are acute, or heal after simple suture, then the advocates of partial gastrectomy will remove many stomachs needlessly. If the skill of the surgeon is not that of a gastric specialist then the risk of operation is greatly increased. Even if gastric symptoms recur after simple suture it is not too late to perform either a short-circuit or a gastrectomy by a second operation when the condition of the patient is better and the indications may be made more definite by X-ray and other examination.

From my remarks it will be evident that I am not an advocate of the more extensive operations. In most cases simple suture, reinforced by an omental graft, gives the patient the best chance of recovery. If the pylorus is very œdematous and the ulcer obviously chronic it may sometimes be wise to perform a short-circuit also. Partial gastrectomy is only justifiable when the ulcer is obviously chronic, the state of the patient good, the surgeon skilled in gastric surgery, and competent assistance at hand. It should be reserved for special clinics.

My own procedure is simple. A 3-in. vertical incision is made just to the right of the mid-line in the epigastrium, and the tube of a suction apparatus is utilized to clear the field whilst the perforation is located and sutured. One suture is put through all the thickness of both sides of the opening and then Lembert sutures are used to invaginate the site of rupture. The sutures are usually passed from above downwards, so that the suture-line is in the long axis of the duodenum or stomach. Fat from the upper and lower borders of the pylorus or from the great omentum is sewn over the suture line. The suction-tube is passed into Morison's pouch, and also well to the back of the subdiaphragmatic space above the liver, to make sure that no collection of fluid is left there. In late cases a tube is inserted in the pelvis through a small suprapubic incision. In early cases no drain is used.

The mortality of cases of perforated peptic ulcer is still much too high. Early diagnosis and quick transport to a surgical centre are necessary if this mortality is to be reduced.

Professor E. R. Flint: During the last twelve years there have been about 100 cases per annum of perforated peptic ulcer, at the General Infirmary at Leeds. In a four-year period there were 397 cases with a mortality of 22·7%.

Of these 49 were perforated gastric ulcers, with a mortality of 32·7%, and 348 perforated duodenal ulcers with a mortality of 20·9%. Taking all cases of perforated duodenal ulcer together, a mortality of about 20% is usual in most hospitals.

In 72 cases of my own the mortality is 15·3%; if from these are subtracted four cases in which perforation had occurred twenty-four or more hours before operation (and in which all the patients died) there are left 68, with a mortality of 10·3%. In these cases the average time between perforation and operation was 6·4 hours.

In order to get more comparable figures I took a further series of 81 hospital cases of operation for perforated duodenal ulcers, in which there had been less than twenty-four hours between perforation and operation; there was, again, a mortality of 20%. The average time between perforation and operation was 6·3 hours.

It is universally agreed that the time between perforation and operation is of vital importance. In these two series, however, the intervening average time was practically the same. I looked through the cases, therefore, to see if there was any essential difference in treatment, and found that all the hospital cases had been treated by simple suture, whereas in more than half of my own cases posterior gastro-enterostomy had been performed as well; in my cases there was a mortality of 9·7%; in those treated by suture only the mortality was 21%.

It appears from these figures that the patient who undergoes gastro-enterostomy has a better chance of survival than when suture alone is done. I realize that the argument would be more convincing had the numbers been greater, and they are presented here with that reservation.

Drainage is seldom necessary in cases coming to operation inside twelve hours; usually suction or gentle mopping is sufficient; in a case, even an early one, showing a large amount of fluid or much turbidity I should advocate suprapubic drainage for twelve hours or so.

After from twelve to eighteen hours of perforation the element of septic peritonitis begins to intervene, when disturbance of the abdominal viscera should be minimal—that is to say, simple suture and drainage constitute the rational treatment.

I have had only occasional experience of excision of a perforated duodenal ulcer and none of pylorectomy or gastrectomy ; I do not think that any of these methods is likely to be of value in the general run of cases.

Perforated gastric ulcer is an even more serious matter, and for this simple suture has been the treatment most widely employed. In my experience the patients in these cases are generally much more seriously ill than those in the perforated duodenal ulcer cases, because of the more devastating effect of the disease in the pre-operative period. Usually they are quite unfit for such a grave operation as gastrectomy.

An interesting point made by my colleague, Mr. L. N. Pyrah, is that of the great number of cases of perforated peptic ulcer dealt with at hospitals now, as compared with the number treated about ten years ago. From 1919 to 1925 the average number of cases per annum at the Leeds General Infirmary was 36. Since 1926 it has been 103. In the same period there has been a decrease in the cases operated on in the chronic stage of the disease from 130 to under 80 cases per annum. It was in the year 1926 or thereabouts, that the treatment of chronic ulcers passed to a large extent into the hands of the physicians.

This is not intended as a criticism of medical treatment of peptic ulcer when properly applied, but it does seem to suggest that the kind of medical treatment which the hospital class of patient receives is, for economic and other reasons, inadequate, and even dangerous, and—further—that prophylactic surgery for this type of patient promises greater safety than medicine as usually applied.

Mr. R. L. Galloway : From our statistical records of the cases of peptic ulcer treated at the North Middlesex County Hospital during the past four years, it appears that the best results were obtained where the simplest method was used and where the operative time was the shortest.

Patients with perforated ulcers are always made worse by travelling in an ambulance and being moved about. For this reason I do not consider it wise to rush them immediately into the operating theatre.

I frequently administer omnopon, scopolamine, or morphia and atropine, and allow the patient to rest in bed in a modified Fowler's position for an hour or two before I operate. The general condition is thus improved and the patient arrives at the operating theatre in a much better state than he was in when he was admitted to hospital.

For anæsthesia I prefer a general inhalation anæsthetic, beginning with gas and oxygen and going on to ether. An anæsthetic which allows the patient to be placed in the Fowler's position immediately, so that the exudate can drain to the pelvis, is in my opinion, the most desirable.

From the statistical tables it will be seen that several methods of treatment have been employed. Personally, I never perform a gastro-enterostomy in a case of perforated peptic ulcer unless the duodenum has become obviously stenosed, either by the disease itself or by the method used at the operation to close the duodenal ulcer. When stenosis is present, and the patient's condition is good, I perform a rapid posterior gastro-enterostomy. I do not think the gastro-enterostomy case does any better than the simple suture case. After simple suture fluids can be given by mouth ; they are rapidly passed through the stomach and into the intestinal canal and the patient can be kept hydrated perfectly well. This is not so in gastro-enterostomy cases and I have the impression that gastro-enterostomy impedes recovery.

With regard to drainage : I cannot say that I am guided by the duration of the perforation as to whether I insert a drain or not. I am guided by the character of the exudate in the peritoneal cavity ; if it is grossly soiled with food I invariably insert a corrugated drain, through a suprapubic stab incision, into the pouch of Douglas.

The following tables summarize the statistics of the series of cases on which these observations are based. Among them are two remarkable cases of perforated stoma ulcer which both happened to be in the same ward at the same time. In both local resection of the ulcer area was carried out and the gastro-enterostomy was repaired. Both patients made complete recoveries.

TABLE I.—CASES OF PERFORATED DUODENAL, GASTRIC AND JEJUNAL ULCERS TREATED BY OPERATION AT NORTH MIDDLESEX COUNTY HOSPITAL FROM 1933-1937.

Type of perforation	No. of cases	Operations	Recoveries	Deaths	Mortality percentage
Duodenal ...	140	140	106	34	24·3
Gastric	75	75	57	18	24
Jejunal	2	2	2	0	0
Total ...	217	217	165	52	24

In 17 cases, not included in these figures, the patients were admitted moribund and died, without operation, a few hours after admission.

TABLE II.—METHODS OF TREATMENT AND RESULTS IN CASES OF PERFORATED DUODENAL ULCERS.

Method of treatment	No. of cases	Recoveries	Deaths	Mortality percentage
Suture only	65	55	10	15·4
Suture + drainage	59	39	20	34
Suture + gastro-enterostomy ...	8	6	2	25
Suture + local resection	8	6	2	25
Total ...	140	106	34	24·3

TABLE III.—METHODS OF TREATMENT AND RESULTS IN CASES OF PERFORATED GASTRIC ULCERS.

Method of treatment	No. of cases	Recoveries	Deaths	Mortality percentage
Suture only (less than 24 hours) ...	43	38	5	11·6
Suture + drainage (over 24 hours)	27	17	10	37
Suture + gastro-enterostomy ...	2	1	1	50
Suture + local resection	3	1	2	66·6
Total ...	75	57	18	24

TABLE IV.—METHODS OF TREATMENT AND RESULTS IN CASES OF PERFORATED JEJUNAL ULCERS IN BOTH CASES GASTRO-ENTEROSTOMY HAD BEEN PERFORMED AT A PREVIOUS OPERATION.

Method of treatment	No. of cases	Recoveries	Deaths	Mortality percentage
Local excision + repair	2	2	0	0
Total ...	2	2	0	0

TABLE V.—CAUSES OF DEATH, INCLUDING THE 17 CASES NOT OPERATED ON.

Cause of death	No.
Toxæmia from general peritonitis	31
Subphrenic abscess	10
Paralytic ileus	7
Hæmorrhage from ulcer	3
Pneumonia	10
Septic bronchitis	5
Uræmia	1
Pulmonary embolus	1
Surgical shock	1

Section of Dermatology

President—H. HALDIN-DAVIS, F.R.C.S.

[*December* 16, 1937, *continued*]

Hydradénome Éruptif of Darier.—D. B. S. BRUCE JONES (by permission of Dr. J. E. M. WIGLEY).

I. M., aged 31, housemaid, gave a five years' history of the eruption, which started around the eyes. Two years ago it began to extend to the forehead and temples.

It consists of nodules varying in size from that of a pin-head to that of a split-pea, mostly discrete, some apparently confluent. Their colour is lighter and yellower than that of the surrounding skin. They are slightly raised above the skin level.

Report on biopsy (Dr. I. Muende): "Good example of hydradénome éruptif of Darier."

With regard to the terminology: The French dermatologists divide the clinical condition into two types: (1) With a distribution over the thorax and abdomen (cuirasse area), appearing from ten to twenty years in successive crops. (2) Hydradénome éruptif des paupières, seen mostly in adult or elderly women, limited to the eyelids, usually the lower. This is the more frequent type. The co-existence of the two types is exceptional.

The American descriptions seem to coincide with the first type, to which the name syringo-cystoma has been applied.

The PRESIDENT: This is an extremely typical case; the section shown under the microscope is exactly similar to an illustration in "La Pratique Dermatologique".

Pityriasis Lichenoides et Varioliformis Acuta.—A. WILLCOX, M.R.C.P. (for H. MACCORMAC, C.B.E., M.D.).

Miss A. H., aged 25.

The eruption was first noticed in the middle of October 1937. The initial lesions appeared on the chest and back, but one week later others developed on the thighs and arms. Since then fresh spots have appeared from time to time. The patient attended the Middlesex Hospital on December 8.

There is nothing significant in the past history except appendicectomy for acute appendicitis on September 14, 1937. The other members of the family are healthy.

The eruption is symmetrically distributed on the arms and chest, in the lumbar region, and on the thighs. It is most profuse on the flexor aspect of the forearms, on the sides of the chest in the axillary line, and in the lumbar region. It is multiform in character, consisting of brownish-red macules and papules, the latter about the size of a small pea. Some of the papules are covered with a scale and some with black, hæmorrhagic crusts, while a few have a central depression. A red halo surrounds some of the papules, particularly those with black crusts. There are no lesions on the mucous membrane of the mouth. There are some enlarged glands in both axillæ and groins.

The patient complains of only slight itching, but she says that some of the hæmorrhagic lesions are painful.

The Wassermann reaction is negative.

Blood-count: R.B.C. 4,480,000 per c.mm.; Hb. 95%. Leucocytes 6,400 per c.mm. (*Differential:* Neutrophils 58·5%; lymphos. 37·5%; monos. 3·5%; eosinos. 0·5%.)

The eruption resembles that in Mucha's illustration (*Archiv. f. Derm. u. Syph.*, 1916, **123**, 586).

Discussion.—The PRESIDENT: I think we have seen a good many of these cases at one time or another. A few years ago there was quite a little crop of them but I do not remember seeing any very lately.

Dr. H. W. BARBER: I agree that this disease is becoming more frequent, after a quiescent period. I have always held that it is the same disease as the non-varicelliform eruption, of which Dr. MacCormac and others have shown cases, and which might be called "pityriasis lichenoides acuta". Injections of gold are worth trying in persistent cases, but it is difficult to assess the value of the treatment in a disease which tends to spontaneous recovery.

Scleroderma and Vitiligo.—H. W. BARBER, M.B.

Daphne S., aged 11.

Family history.—An only child. Both parents well. Maternal grandparents alive and in good health; grandmother is said to have a pigmented patch on one shoulder. Paternal grandparents both dead; grandfather died at the age of 76 of "muscular atrophy" (? tabes, ? amyotrophic lateral sclerosis); grandmother died of cardiac thrombosis. Patient's father is the youngest of five.

Personal history.—The changes in the skin were first noticed on the left leg in February of this year. The child is of the nervous apprehensive type, and is particularly afraid of dental treatment. She was a full-time child born nine months after her parents' marriage.

Present condition.—The cutaneous changes provide an interesting association of vitiligo and scleroderma, and the distribution is curious. There is scleroderma of the "white-spot" type involving the supraclavicular and infraclavicular fossæ, the suprascapular regions and deltoid eminences, and the presternum and adjacent parts. There is a patch of morphœa over the left breast, and large irregular patches on the abdomen. The vitiligo is present on the left side of the abdomen, extending from below the umbilicus to the pubic region, left groin, upper thigh, knee, leg, and ankle. The scleroderma and vitiligo occur together over the left buttock, outer side of the left thigh, and on the anterior surface of the left leg. The right thigh and leg are not affected.

There are some pigmented moles, with depigmented halos (leucoderma acquisatum centrifugum of Sutton), which are so commonly present in patients with vitiligo and to which my attention was directed during the Great War at about the time Sutton published his paper. They are of course quite common, and may occur independently of vitiligo.

The point I would like to have discussed is that of the ætiology. In France, particularly, great importance is attached to syphilis, either acquired or inherited, in the ætiology of vitiligo. During the War, when large numbers of cases of syphilis were under observation, vitiligo was very common. Dr. Brown, of Glasgow, wrote an article on the subject. With regard to cases of vitiligo in this country, I do not think syphilis enters into the causation as frequently as French dermatologists think it does in France. In this case I could not discover any apparent provoking cause. The paternal grandfather is said to have died of "progressive muscular atrophy" at the age of 76. I think anyone with that disease is unlikely to reach that age, and I wonder whether what he had was amyotrophic lateral sclerosis, which is, of course, syphilitic in origin in some cases.

Another point about this child is a very irregular dentition, and this the French would assume to be a stigma of inherited syphilis, if not in the first generation, in the

second. I asked Mr. Rix to look at the case, and he did not think the stigmata here were sufficiently marked to justify conclusions being drawn from them. Both Wassermann and Kahn reactions are negative, but that is only to be expected if this is a case of syphilis in the second generation.

Dr. F. PARKES WEBER said that this was one of the rare examples of genuine vitiligo associated with superficial sclerodermia. In most cases of vitiligo which he had seen there had been no evidence of syphilis.

[*January* 20, 1938]

Chauffard-Still-Felty Syndrome.—H. MACCORMAC, C.B.E., M.D.

The patient, a man aged 22, is a native of Cyprus, and came to England in 1935. He has had no previous illness, except malaria. About a year ago he had swelling of the fingers and wrists, accompanied by pain, and shortly afterwards similar symptoms developed in the feet and ankles. Three months later oval red areas appeared over the knuckles, which have now become depigmented and atrophic; on the palmar surface of all the fingers the skin is thin and shiny.

Since the patient's admission to the Middlesex Hospital on 16.7.37 there has been a progressive increase of pigmentation, especially on the face, hands, elbows, and knees. There is a trace of pigmentation of the buccal mucosa. The face is somewhat swollen, especially under the eyes, where a reddish tinge shows through the pigment.

On 16.9.37 tenosynovitis of the wrists and forearms (flexor and extensor sheaths) and of the ankles developed.

Physical examination: No abnormal signs except palpable spleen and enlargement of epitrochlear, sub-occipital, and axillary lymphatic glands. Nervous system: Normal; ulnar nerves not enlarged. There appears to be some loss of sensation to pain and touch over the atrophic areas on the hands.

X-ray examination: Lungs normal. No evidence of enlarged glands in thorax; no bony abnormality detected in hands, knees, or feet. Pituitary fossa within normal limits.

Blood-count, 20.9.37: R.B.C. 3,400,000; Hb. 75%; W.B.C. 4,500 (neutros. 74%; lymphos. 16%; monocytes 10%). A later count gave W.B.C. 7,000. Cultures and smears from the enlarged tonsils showed the usual mouth organisms but no hæmolytic streptococci.

Sugar tolerance test: Curve normal. Fractional test-meal: Results normal. Sedimentation rate unusually rapid. Blood-pressure 110/60. Blood chlorides, 585 mgm. %; potassium 19 mgm. %; sodium 325 mgm. % (sodium-potassium ratio normal. In cases of suprarenal dysfunction a disturbance of the blood sodium—potassium ratio may be found). This investigation was made in an endeavour to obtain some light as to the nature of the abnormal skin pigmentation.

Microscopical examination: A lymphatic gland showed only simple lymphadenitis with follicular hyperplasia. A section of the skin over the elbow showed a pronounced deposit of melanin granules in the dermis.

The Wassermann, Mantoux, and gonococcal complement-fixation reactions are negative.

The credit for the diagnosis in this extremely puzzling case is due to Dr. Parkes Weber, who kindly saw the patient and gave me his authoritative opinion. It is therefore appropriate to quote his opening remarks in a communication to the Clinical Section in April 1937 :—

"Felty's syndrome is a convenient term for the combination of symptoms of chronic or subacute rheumatoid arthritis in an adult, with enlargement of superficial lymphatic glands and spleen. Though the exact causation of the syndrome is not known, it is probably of chronic infectious nature and analogous to 'Still's disease' in children."

[1] *Proceedings*, 1937, **30**, 932 (Clin. Sect. 32).

Felty's summary of his original paper is as follows[1] :—

"Five cases, strikingly similar in their essential features are described, presenting an unusual, but unmistakable, clinical picture, characterized by arthritis, splenomegaly and leucopenia. The etiology is entirely obscure, though the various findings seem best accounted for as manifestations of a single disease process."

The present case appears to come into this group, presenting, as it does, the features which Felty describes, including glandular enlargement and pigmentation. It differs, however, in that the leucocyte count is normal, whereas in Felty's five cases leucopenia was a distinctive and constant feature. (Leucopenia, it may be mentioned, is not a feature of Still's disease.) The case differs also to some extent, from Felty's cases, in the pronounced cutaneous manifestations, especially the extreme degree of pigmentation, the morphœa-like lesions on the back of the hands, and the loss of hair on the scalp.

Dr. PARKES WEBER said that he was not familiar with the association of cases of this class with definite skin symptoms. An important point in the present case was the microscopical examination of one of the supratrochlear lymph-glands, which showed no evidence of tuberculosis. He had hoped that a change-back from the cold damp winter of England to Mediterranean sunlight would be of help, but he had been rather disturbed by looking at the latest number of the *Presse Médicale*, January 15, 1938, p. 85. The first two cases discussed at the Algiers Medical Society were cases of the Chauffard-Still-Felty syndrome, and in each of them splenectomy was performed. Therefore, evidently the Mediterranean climate could not be regarded as a certain cure.

? Scleroderma : Case for Diagnosis.—L. FORMAN, M.D.

A. W., male, aged 29. Admitted to Guy's Hospital in November 1937.

History.—Rash for past nine months on tips of ears, scalp, fingers, and chest, after exposure to cold. Bowels opened three times daily ; some mucus and blood in the stools. When seen six months ago there were on the backs of the knuckles and tips of the ears, erythematous, raised, hyperkeratotic areas with plugged follicles. Over the chest and back the skin was red, and over the scalp there was some scaling. The diagnosis was lupus erythematosus. Two 0·01-grm. doses of solganol B were given and produced an exacerbation of the bowel symptoms. W.B.C. 12,000 ; differential count normal.

Present condition.—There is an erythematous patch over the chest, with an atrophic area in the centre. If the skin is stretched, small follicular buff-coloured papules can be demonstrated. There are similar areas in the middle of the back.

Microscopical examination : The lesions on the knuckles show œdema of the papillary bodies, and vascular dilatation. In the lesions on the chest the connective tissue shows some condensation and homogenization and the elastic tissue is diminished in places. "The appearances are those one would expect to find in a superficial scleroderma or in dermatomyositis" (Dr. W. Freudenthal).

Sigmoidoscopy : Ulcerative colitis ; the mucous membranes are congested and bleed easily. Skiagrams of chest and colon : No abnormality shown.

The stools contained hæmolytic streptococci and paracolon bacilli.

Agglutination tests for dysentery (Shiga, Flexner, and Sonné) negative.

Dr. G. B. Dowling thought that a form of dermatomyositis was a possible diagnosis, but there has been no history of muscular pains or stiffness, nor is there any muscular weakness, and there are no reflex changes.

Dr. H. MACCORMAC : I remember seeing a somewhat similar case several years ago. It was very puzzling in its initial stages, but eventually developed the characteristic appearance of pityriasis rubra pilaris. This may prove to be the eventual diagnosis in this case.

[1] *Bull. Johns Hopkins Hosp.*, 1924, **35**, 16-20.

Lichen Planus, with Involvement of the Tongue, and Finger- and Toe-Nails.—H. C. SEMON, M.D.

Mrs. E. W., aged 53.

29.7.37: Was admitted to the Royal Northern Hospital with thirteen weeks' history of soreness of the tongue, swelling of the glands of the neck, and severe debility. A month after the onset the feet began to ache, and blisters appeared on the soles. There was concomitant swelling and inflammation of the nail-beds of the toes and fingers. A fortnight before admission the patient noticed an irritable rash on the trunk and forearms. This was undoubtedly lichen planus of an acute type, and rendered the diagnosis of the tongue affection—which would otherwise have suggested moniliasis, owing to its macerated and denuded character and the associated paronychia of all the nails—a virtual certainty. The latter diagnosis was later negatived by the absence of yeast-like bodies both on direct examination and culture of scrapings from the tongue and nail-folds. Streptococci only were grown. The Wassermann reaction was negative, and there were no abnormalities in a differential count of the red and white cells of the blood.

The left side of the tongue is still exceedingly painful, and presents a swollen, erythematous, and denuded area which has so far not responded to treatment. All the nails, both of fingers and toes, have been shed once, and the toe-nails are yellowish and opaque, with pronounced longitudinal striations (onychorrhexis). This feature is stated by Pardo-Castello ("Diseases of the Nails", 1936, p. 109) to be the one most often seen in an otherwise rare manifestation. The less characteristic dystrophy on the finger-nails is of course commonly noticed in chronic dermatitis due to a variety of causes.

A case very similar to this was shown by Mr. Corsi in November 1936,[1] but in that case there was a much more definite and permanent nail change, since the nails did not grow again and, as Mr. Corsi said, the appearance was as if there had never been any nails. There are brownish atrophic macules on the forearms and on the instep there is a discoid residue of violaceous tint—suggesting lichen planus. I should be glad to know if any members have tried the effect of X-rays on tongue lesions of this type, because the usual treatments have completely failed to relieve those in this case.

Discussion.—Dr. HUGH GORDON: At the West London Hospital we had a case of extensive lichen planus of the tongue under observation for two years; the diagnosis was at first only tentative but was confirmed after some months by a generalized skin eruption typical of the condition. I believe that the tongue was treated by X-rays, without benefit. The generalized eruption and the affected area on the tongue were cured by injections of bismuth.

Dr. F. A. E. SILCOCK: I have used X-rays for similar lesions on the tongue, uvula, and buccal mucous membranes. The doses have been small—one-fourth of a pastille repeated in two weeks, up to a total of three or four such doses in all. For acute lesions I use a 0·5 mm. aluminium filter. The response is as a rule, satisfactory. In a recent case a generalized long-standing eruption with mouth lesions which had proved obstinate under other methods, cleared up perfectly under treatment by X-rays.

Dr. FORMAN said that he had seen a rather similar atrophic tongue in a patient with typical lichen planus of the skin. The tongue, which had been superficially ulcerated, had improved considerably while the patient was having small injections of gold salt. He would hesitate to treat Dr. Semon's patient with X-rays, as there was already so much atrophy in evidence.

Premycotic Erythema.—G. B. DOWLING, M.D.

Male, aged 66. Pruritus of generalized distribution began about twelve years ago. For several years, during which the diagnosis of senile pruritus was made, there were no objective signs. For about three years large areas of erythema have

[1] *Proceedings*, 1937, **30**, 198 (Sect. Derm., 18).

appeared; these are sharply limited and very slightly raised. Pruritus is intense. The erythematous areas persist for considerable periods, undergoing some slight alteration in shape from time to time.

Histology.—Beneath a normal epidermis, and separated from it by a narrow interval, a narrow dense band of cellular infiltrate is seen. The cells are chiefly of the endothelial type, and among them there are occasional clumps of from three to five or six cells aggregated to resemble a giant-cell and bearing some resemblance to Sternberg cells.

Blood-count normal, on several occasions. No enlargement of glands or spleen. The patient's general health is good, but the irritation worries him a great deal. The erythema seems too extensive for X-ray therapy, and I should be glad of other suggestions for treatment.

Discussion.—Dr. A. C. ROXBURGH: In 1936 Dr. MacCormac reported two cases of mycosis fungoides in which erysipelas developed, and in which the mycosis afterwards disappeared.[1] I have not ventured to give anybody erysipelas, but during the last year or two I have treated one case of mycosis fungoides with malaria and another by short-wave diathermy. Neither treatment did good. The patient who had malaria grew steadily worse and went downhill faster than before, and the patient who had diathermy was unaffected in any way.

Dr. MACCORMAC: I am sorry Dr. Roxburgh has had such unfortunate experience with the treatment; it is not entirely free from danger. I have just had a very disquieting experience in the case of a woman who had mycosis á tumeurs d'emblée. The tumours cleared up, but unfortunately suppression of the urine developed, and only after a long and difficult fight were we able to save her life. This is, of course, a complication which is sometimes found in the treatment of general paralysis, but I should have thought that to otherwise healthy people suffering from mycosis fungoides this treatment might safely be administered. In the present case it would be worth considering.

Dr. FORMAN said that he had endeavoured to inoculate hæmolytic streptococci into the skin in order to produce an attack of erysipelas in a patient suffering from mycosis fungoides, but had failed to do so. Another patient with mycosis fungoides, showing widespread, irritable erythema, with tumours, was treated with malaria and allowed to have seven rigors. The irritation and tumours disappeared and she felt quite comfortable. She returned at the end of three months, complaining of some irritation and erythema, without, however, any tumour formation.

Dr. H. SEMON: A warning I should like to give is that the blood in these cases should be carefully examined, especially if the patient has already had X-ray treatment. In one such case, which came to me from the North, this precaution was not observed, and the patient was inoculated with malaria. Later in the day I happened to notice that he was extremely pale. His blood was therefore examined and found to contain only about 1½ or 2 million red cells.

We promptly aborted the inoculation, but the patient died within a week, from aplastic anæmia—probably the result of long and frequently-repeated X-ray treatment.

Dr. F. F. HELLIER: I am interested in the case mentioned by Dr. Semon. We had a similar experience in a case of mycosis fungoides in which we gave malaria. The patient had a persistently high temperature, in spite of quinine treatment, and severe aplastic anæmia developed. We could not tell whether the temperature was due to the malaria or to the mycosis fungoides. Although she had a number of blood transfusions, she died. She had had a good deal of X-ray treatment and, as Dr. Semon has suggested, this may have helped to produce the anæmia. It therefore seems important always to take a blood-count before giving malaria.

As regards Dr. Dowling's case, the dose of X-rays required to improve the condition in mycosis is usually so small that the treatment is worth trying, and it is free from any danger provided that the X-rays are not repeated too often and that malaria is not given to the patient.

Dr. PARKES WEBER said that therapeutic malaria was a very severe measure. Some time ago he saw a woman who after therapeutic malaria had had a rapid recurrence of her

[1] *Brit. J. Derm. and Syph.*, 1936 **48**, 201.

dermatosis, which had been diagnosed as an intolerably itching premycotic erythrodermia. She told him that a repetition of the malaria inoculation had been offered her, but she would rather put her head in a gas oven than have it again. As a matter of fact, this poor woman afterwards obtained medinal from some hospital and killed herself with it. The Coroner's pathologist, who had not heard of the diagnosis when he made the post-mortem examination, said that the skin condition was a pruriginous dermatitis.

Pigmented Dermatitis associated with Pernicious Anæmia.—HUGH GORDON, M.C., M.R.C.P.

William D., aged 59, previously healthy, has suffered from chronic eczema on the back of both hands ever since the Great War; the rest of the skin has been clear. For the last seven months he has felt debilitated. Eight weeks ago his teeth were extracted; soon afterwards his legs began to swell and a dermatitis appeared on the legs and trunk. When first seen he was obviously anæmic, and a lichenified dermatitis covered his legs, which were œdematous.

Blood-count: R.B.C. 1,740,000 per c.mm.; Hb. 47%; C.I. 1·38; leucos. 4,700 per c.mm. Anisocytosis, poikilocytosis, macrocytosis.

Test meal: Complete achlorhydria. Van den Bergh reaction: Indirect, 2·8 units bilirubin.

Progress.—He has been given anhæmin, 2 c.c. bi-weekly, hydrochloric acid by the mouth, and large doses of marmite. The blood picture has improved slightly. Reticulocytes have increased from 2% to 10% in the month. The improvement of the skin has been most dramatic. The legs and forearms, which were covered with a sheet of lichenified dermatitis, are now practically clear, though extensive pigmentation remains. On the legs there are a few scattered patches of lichenification. On the sacrum are still to be seen some confluent areas which at one time were practically indistinguishable from lichen planus. The œdema of the legs subsided within a week; the irritation, which was considerable, is now very much less.

The particular interest of this case for the dermatologist is the question whether the skin eruption is simply a chronic eczema of unknown ætiology, or can be definitely attributed to any aspect of the patient's general condition. The coincidence of the swelling of the legs, followed by the widespread dermatitis—and the onset of grave anæmia, must, I think, suggest their interrelation. Accounts of skin manifestations in pernicious anæmia are not particularly common, though the mucous membranes are known to be involved in some microcytic anæmias.

This case forcibly reminded me of one which I saw at the West London Hospital with Dr. G. Konstam and which was shown at a meeting of the Clinical Section in February 1936.[1] It was a case of idiopathic steatorrhœa with megalocytic anæmia. The patient had fixed lichenified, intensely-pigmented, skin lesions of three years' duration. It appeared on investigation that these lesions—termed "pellagra-like"—were not uncommon in this condition. In that case there was, of course, grossly insufficient absorption from the gut, which easily explained a condition of hypovitaminosis. The skin cleared up completely—and, so far, permanently—under the administration of large doses of vitamin B in the form of marmite. The blood-picture was practically unaltered though a long and varied course of hæmatins was given. In that case, therefore, there seemed no doubt that the skin lesions were definitely caused by the hypovitaminosis.

Vitamin B is an essential factor in the formation of the normoblast, and it is suggested that the dermatitis—which in that instance was of a particularly lichenified type, with fairly intense residual pigmentation—was a syndrome connected with a grave hypovitaminosis.

[1] *Proceedings*, 1936, **29**, 629 (Clin. Sect., 23).

An Unusual Type of ? Lichen Planus.—HUGH GORDON, M.C., M.R.C.P., and W. FREUDENTHAL, M.D.

Male, aged 56.

History.—Gradually spreading eruption of seventeen years' duration.

Present condition.—The scalp is scaly. The face shows a number of fixed, flat, fawn-coloured lesions, which are covered with a thin adherent scale. There is no induration. The appearance of these lesions is rather suggestive of the Senear-Usher syndrome. The rest of the body is practically covered. There are a few islands of normal skin on the trunk and arms which show pigmented stains.

The essential lesion appears to be an erythematous patch of varying size. These in many places suggest a pemphigoid eruption in that the stratum corneum appears to be raised. Over the whole back the stratum corneum looks wrinkled and rather loose. Nikolsky's sign, however, cannot be obtained. On the forearms and neck the lesions are definitely infiltrated but not lichenified. In the sacral area are still vegetative lesions which, one month ago, practically covered the entire legs. The mucous membranes are clear.

Biopsy taken from an infiltrated lesion on the right forearm suggests lichen planus as the probable diagnosis.

Histological report: Hyperkeratosis in places. Keratohyalin layer increased. Downgrowth of the epithelial pegs of the rete. Between the epidermis and the papillary body are half-moon shaped clefts. The papillæ are dome-shaped. In the tips are numerous closely aggregated colloid blocks, staining yellow with van Gieson, pink with eosin. In the upper third of the cutis are fibroblasts, a moderate round-cell infiltration, and some mast cells. Elastic fibres destroyed.

The two clinical suggestions—mycosis fungoides or pemphigus,—are difficult to reconcile with the histological appearance, which points to lichen planus of a verrucose and somewhat bullous form. The peculiar connective-tissue degeneration also favours a diagnosis of lichen planus; it has been described in that disease by Jarisch and been confirmed by Kyrle, but is in such an extent unusual.

Dr. I. MUENDE asked Dr. Freudenthal how he interpreted the presence of the clefts between the epidermis and the dermis. These appeared to be full of fluid and might account for the positive Nikolsky's sign.

He thought that the degenerative changes in the collagen of the papillæ were much more widespread than was usually the case in acute lichen planus in which eosinophilic masses were sometimes found in the tips of the papillæ only.

Dr. W. FREUDENTHAL (in reply) said that clefts between the epidermis and the dermis were a fairly frequent finding in lichen planus. He interpreted them as indicating some tendency towards exudation. When—in rare cases—this became excessive, a clinically visible blister was formed (lichen planus bullosus).

It was generally accepted that Nikolsky's sign was a decortication of the horny layer; histologically, the plane of cleavage was found between the stratum granulosum and the stratum lucidum. Dr. Gordon, in his report, had said that he could not obtain the sign and several members who had tried to obtain it at the meeting had been unable to do so.

Section of Odontology

President—FRANK J. PEARCE, L.D.S.E.

[*January* 24, 1938]

An Experimental Investigation into the Association of Traumatic Occlusion with Parodontal Disease

By H. H. STONES, M.D., M.D.S., L.D.S.Eng.

(*From the Research Department of the School of Dental Surgery, Liverpool University*)

ABSTRACT.—(1) The production of traumatic occlusion by inserting raised fillings in the teeth of monkeys is described. The fillings were inserted in three adjoining posterior teeth, one being left higher than the others. In one monkey an upper central incisor was the only tooth treated and on this was fixed a raised metal crown.

(2) Experiments were terminated after varying periods of time, from ten to forty-three weeks. The jaws containing the teeth in which raised fillings were inserted, the opposing teeth, and the controls, were sectioned. Some sections were cut mediodistally and others facio-lingually.

(3) Results. These were judged from a histological examination of the sections.

(*a*) Seven monkeys were treated. (*b*) In three monkeys very definite changes analogous to parodontal disease were produced. (*c*) In three monkeys less extreme changes were seen. (*d*) In one monkey there was no change. (*e*) in each animal the pathological changes were usually observed in only the one tooth which took the greatest stress of the thre- that were filled and the opposing one with which it articulated. (*f*) Of the 39 teeth subjected to trauma eleven showed pathological changes in the subgingival tissues.

(4) The clinical evidence in man is considered.

(5) The conclusion is reached that traumatic occlusion is an ætiological factor in the production of that variety of parodontal disease in which there is vertical pocket formation associated with one or a varying number of teeth.

RÉSUMÉ.—1. Description de la production d'une occlusion traumatique chez le singe par des plombages surélevés. Trois molaires consécutives furent plombées, avec un plombage plus haut que les autres. Dans un singe la seule dent traitée fut une incisive centrale supérieure, sur laquelle une couronne surélevée en métal fut fixée.

2. Les expériences furent terminées après 10 à 43 semaines. Les mâchoires contenant les dents plombées, les dents opposées et les contrôles furent sectionnées, quelquefois en direction médio-distale et quelquefois en direction faciolinguale.

3. Résultats, jugés d'après l'examen histologique des sections:

(*a*) Sept singes furent traités.

(*b*) Un état pathologique analogue à une maladie paradentaire fut produit chez trois singes.

(*c*) Chez trois autres il se trouva des changements moins marqués.

(*d*) Chez un singe il ne se trouva aucun changement.

(*e*) Chez tous les singes les dents affectées furent celle qui avait subi le plus grand effort et la dent opposée.

(*f*) Un état pathologique du tissu sous-gingival fut trouvé dans 11 dents sur 39 dents traitées.

4. L'auteur examine l'évidence clinique chez l'homme.

5. Il arrive à la conclusion que l'occlusion traumatique est un facteur étiologique dans la production de la forme de maladie paradentaire qui s'accompagne de la formation de poches verticales dans une ou plusieurs dents.

ZUSAMMENFASSUNG.—1. Verfasser beschreibt die experimentelle Erzeugung traumatischer Okklusionen durch erhabene Füllungen in Affenzähnen. Die Füllungen wurden an 3 benachbarten Backenzähnen vorgenommen u.zw. derart, das die eine Füllung höher gelassen wurde als die beiden anderen. Bei einem Affen wurde nur ein einziger oberer mittlerer Schneidezahn mit einer erhöhten Metallkrone überkront.

2. Die Versuche wurden zu verschiedenen Zeiten, u.zw. nach 10-43 Wochen abgebrochen. Die Teile der Kiefer, welche die Zähne mit den erhabenen Füllungen enthielten, sowie die gegenüberliegenden Zähne und Kontrollen wurden histologisch untersucht; zu diesem Zweck wurden sowohl mediodistale als auch faciolinguale Schnitte hergestellt.

3. Die histologische Untersuchung der Schnitte führte zu folgenden Ergebnissen:

(*a*) Die Untersuchung wurde an 7 Affen vorgenommen.

(*b*) Bei 3 Affen wurden sehr deutliche Veränderungen erzielt, die denen bei Paradentose analog waren.

(*c*) Bei 3 Affen wurden weniger ausgesprochene Veränderungen festgestellt.

(*d*) Bei einem Affen wurden überhaupt keine Veränderungen gefunden.

(*e*) Bei allen Tieren wurden im allgemeinen die pathologischen Veränderungen nur an demjenigen der drei Zähne gesehen, der am meisten beansprucht worden war, ferner an dem gegenüberstehenden Zahn, mit dem er artikulierte.

(*f*) Von den 39 traumatisch veränderten Zähnen zeigten 11 pathologische Veränderungen im subgingivalen Gewebe.

4. Die klinischen Erscheinungen und Befunde beim Menschen werden zum Vergleich herangezogen.

5. Verfasser kommt zu dem Schluss, dass traumatische Okklusion bei derjenigen Form paradentaler Erkrankung eine ursächliche Rolle spielt, die durch vertikale Taschenbildung an einem oder mehreren Zähnen ausgezeichnet ist.

INTRODUCTION

Various classifications of gingival infections have been put forward, and while it is not proposed in this paper to enter into a discussion from this aspect, it is generally acknowledged that amongst others the following two distinctive types can be recognized when the condition is chronic and fully developed :—

(1) Where there is a generalized horizontal absorption of the alveolus with concomitant pocket formation.

(2) Where there is an irregular vertical absorption of the alveolus round only one or a varying number of teeth. Usually this absorption affects one side of the tooth concerned more than the other and is associated with a deep vertical pocket.

Type 1 is analogous to the periodontitis simplex described by Box (1928) and the chronic gingivitis of Fish (1935). Type 2 is the periodontitis complex variety of Box and the idiopathic pyorrhœa of Fish.

Of the many theories which have been advanced about the ætiology of these conditions, in recent years there has been much discussion about the effects of traumatic occlusion on the gingival sulcus and the subsequent production of parodontal

disease. Those writers who have supported this hypothesis have usually associated it with the before-mentioned type 2. At the outset it may be said that many diverse opinions have been expressed, some observers stating that it is an all-important factor, while others maintain that any ill-effects are negligible. Karolyi (1901) was one of the first to draw attention to the possibility of undue stress being associated with the production of pyorrhœa. More recently and for a number of years, Stillman and McCall (1922 and 1937) have held, and still maintain, that this is the chief ætiological factor involved. Box (1928) for some time has been in agreement with this view; Bunting (1937) attaches considerable importance to it. These conclusions have, however, only been drawn from the clinical observation of cases of traumatic occlusion such, for example, as follow excessive closebite or early extraction of certain posterior teeth.

An experimental examination of the situation was forthcoming when the results of the joint investigation of Gottlieb and Orban (1931) and Kronfeld (1933) into the effects of the production of undue stress in both vertical and horizontal directions were published. Working almost entirely on dogs, their procedure was to fix a high crown on a tooth. As opposed to the clinical findings of the writers who have been mentioned above, they found that the gingival sulcus was not affected, except by the edge of the crown which produced an unhygienic area, and they concluded that there was no evidence to support the view that traumatic occlusion was of importance in the production of parodontal disease. Box (1935) on the other hand, fixed a crown on a lower incisor of one sheep and found that the sulcus was deepened, with all the signs of gingival infection.

It can thus be seen that entirely diverse views are held by different observers. The object of this investigation has been to explore experimentally the effects of increased stress on the gingival sulcus, in the hope of further elucidating the problem.

Method

Experiments were started in 1932 and were carried out on seven monkeys. With regard to age, animals were chosen with the permanent canines fully erupted but with teeth not suffering from attrition. In six cases cavities were cut in the occlusal surface and considerably raised fillings were inserted in three posterior teeth on one side of the jaw. In some animals the fillings were inserted in the maxillary teeth and in others in the mandibular ones. Two of the fillings were amalgam and the other cement. The object of using the latter material was that as it sets quickly it keeps the bite open until the amalgam has hardened. These materials were used in preference to inlays because of the facility of manipulation. It was decided to subject three adjoining teeth to increased stress as opposed to one, as the force would then not be so extreme and would tend to approximate more nearly to conditions of traumatic occlusion in man. The amalgam fillings were arranged so that one was higher than the other, as it was felt that variable stress in the different teeth would be of interest. In one monkey the only tooth which was subjected to increased stress was the left upper central incisor on which a raised crown was fixed.

Thirty-nine teeth were thus subjected to traumatic occlusion, including those opposed to the raised fillings. Experiments were terminated after periods of time varying from ten to forty-three weeks. Serial decalcified sections were afterwards prepared of the treated teeth and of the controls on the opposite side of the mouth by the butyl alcohol method for histological examination. Some sections of the three treated teeth and of their controls were cut mediodistally in one or two blocks, while others were cut faciolingually.

Details of Experiments and Results

At the outset it must be said that it was determined to decide what effects, if any, were produced on the gingival sulcus from an histological examination of the epithelial attachment to the tooth and of the underlying connective tissue. The question of estimating the comparative depth of the resultant gingival sulcus was considered, but it was felt that, as the stress was vertical, or only partly oblique, the tooth would probably be gradually driven into the jaw and hence a comparison would be difficult and uncertain. This depression of the tooth was easily observed in the case in which only one tooth was treated (figs. 14 and 15). Further, as deepening of the gingival sulcus or pocket formation does not develop until the disease has advanced to a certain stage, it was felt that experiments of much longer duration would be necessary before this stage could be reached.

The usual gingival sulcus found in the untreated adult monkey is shown in fig. 4. It is seen that the subgingival epithelium appears as a smooth band which joints neatly on to the cementum, but does not extend along it. The enamel has, of course, been removed by decalcification. The underlying connective tissue is almost free from inflammatory cells.

It is now usually accepted, as was shown by James and Counsell (1927), that in man, when parodontal disease commences, there is proliferation of the subgingival epithelium along the cementum and also in papillary processes into the underlying connective tissue. The latter is infiltrated with lymphocytes and plasma cells. As the disease progresses this epithelial proliferation along the cementum becomes detached from the tooth surface, thereby deepening the gingival sulcus. Similar changes have been observed by the writer (Stones, 1932) in the gingival tissues of dogs affected with the disease and, as will be seen, can be produced in monkeys.

In considering the results of the experiments, which will each be described separately, it is postulated that if the early histological changes just reviewed are produced, this is an indication that parodontal disease will tend to develop. Cases 1, 2, and 3 show these changes very definitely ; Cases 4, 5, and 6 show them slightly ; Case 7 is not affected.

To facilitate reading, the following method of enumerating teeth, which is that most frequently used in Great Britain, has been adopted :—

Right	Left
87654321	12345678
87654321	12345678

Case 1 (*326*).

Experiment : |5 Raised amalgam filling.
|6 Raised amalgam filling (greatest stress).
|7 Raised cement filling.
Duration twenty-one weeks.
All sections cut mediodistally.

Result : Wandering of the teeth is marked as is shown by the difference in the centres of the maxillary and mandibular incisors (fig. 1).
|6 Typical pathological changes of parodontal disease (figs. 2, 3*a* and 3*b*)
|5 Slight pathological changes.
|7 Unaltered.
6| Control is normal (fig. 4).
|6 Typical pathological changes of parodontal disease (figs. 5 and 6).
|57 Unaltered.
67| Control is normal.

FIG. 1.—Case 1 (326). Raised fillings in | 567. Duration twenty-one weeks. A slight difference in the centres of the first maxillary and mandibular incisors has been produced.

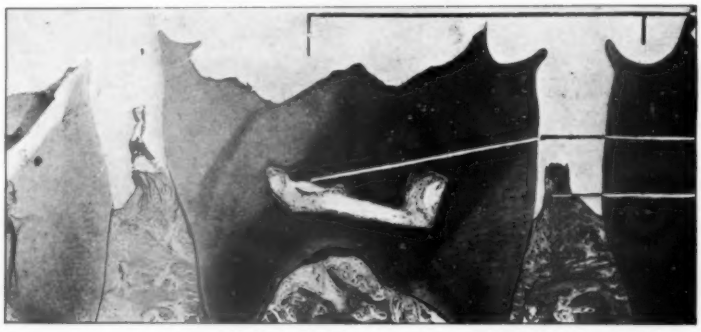


FIG. 2.—Case 1 (326). Raised fillings in | 567. Greatest stress on | 6. Duration twenty-one weeks. General view, out cavity (Cav.) is observed. | 6 is the only tooth to show pathological changes in the subgingival epithelium (E.) and underlying tissues. The pulp has undergone degenerative changes and secondary dentine has been formed (S.D.). × 10.

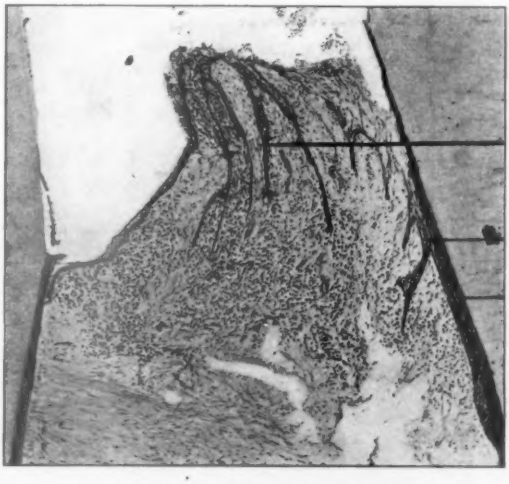


FIG. 3a.—Higher magnification of fig. 2. Gingival sulcus of | 56. × 65. Subgingival epithelium (E.). Connective tissue (C.T.). Cementum (C.).

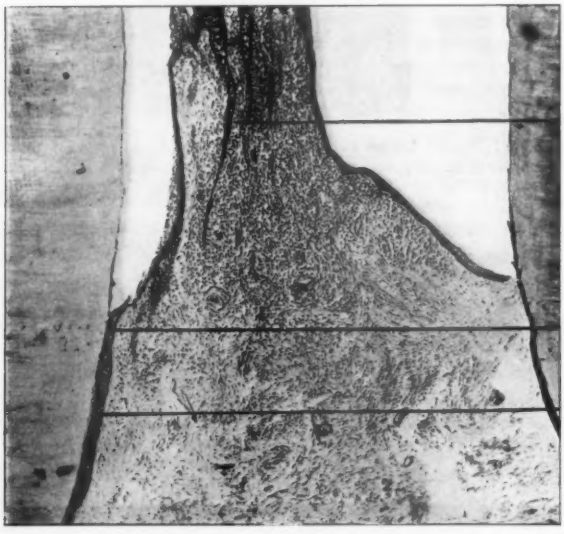


FIG. 3*b*.—Higher magnification of fig. 2. Gingival sulcus of | 67. On both medial and distal sides of $\underline{|\,6}$ (figs. 3*a* and 3*b*) there is proliferation of the subgingival epithelium (E.) along the cementum (C.) and into the underlying connective tissue (C.T.). The latter is densely infiltrated with lymphocytes and plasma cells. In $\underline{|\,5}$ and $\underline{|\,7}$ the epithelial attachment is practically normal and there are but few round cells. × 65.

FIG. 4.—Case 1 (326). $\underline{6\,|}$. Control tooth on the opposite side. The gingival sulcus is normal. Compare with fig. 3*b* (E.). × 65.

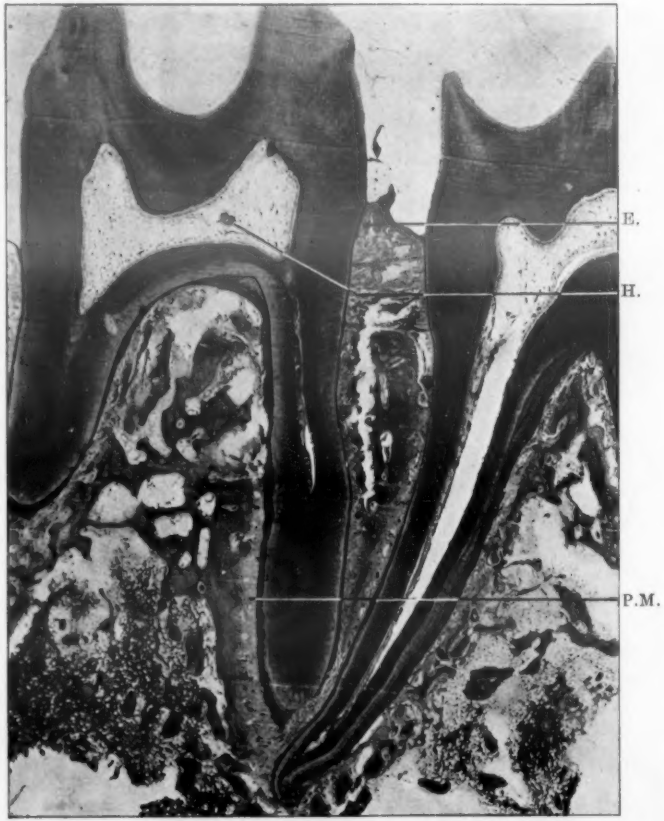


FIG. 5.

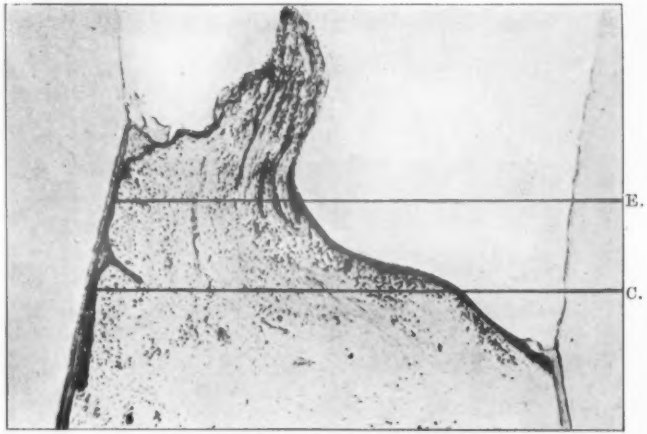


FIG. 6.

FIG. 5.—Case 1 (326). $\lfloor \overline{67}$. Opposing raised fillings in $\lfloor 567$—general view. Extreme stress on $\lfloor \overline{6}$ has forced the root against $\lfloor \overline{7}$ and partly resorbed the apex. The periodontal membrane (P.M.) is stretched on the opposite side. There is proliferation of epithelium (E.) along the cementum of $\lfloor \overline{6}$. A hæmorrhage (H.) is seen in the pulp. × 10.

FIG. 6.—Higher magnification of fig. 5 showing the pathological subgingival tissues in $\lfloor \overline{6}$ and the normal sulcus of $\lfloor \overline{7}$. In $\lfloor \overline{6}$ there is proliferation of the subgingival epithelium (E.) along the cementum (C.) and into the underlying connective tissue, which is infiltrated with lymphocytes and plasma cells. × 90.

Case 2 (73) Young.

Experiment: 4| Raised amalgam filling.
6| Raised amalgam filling (greatest stress).
7| Raised cement filling.
Duration thirteen weeks.
All sections cut mediodistally.

Result: 6| Typical pathological changes of parodontal disease (figs. 7, 8*a*, 8*b*, and 8*c*).
74| Unaltered.
|6 Control: Normal attachment on distal side (fig. 9). Slight pathological changes on medial side.
6| Typical pathological changes of parodontal disease.
75| Unaltered.

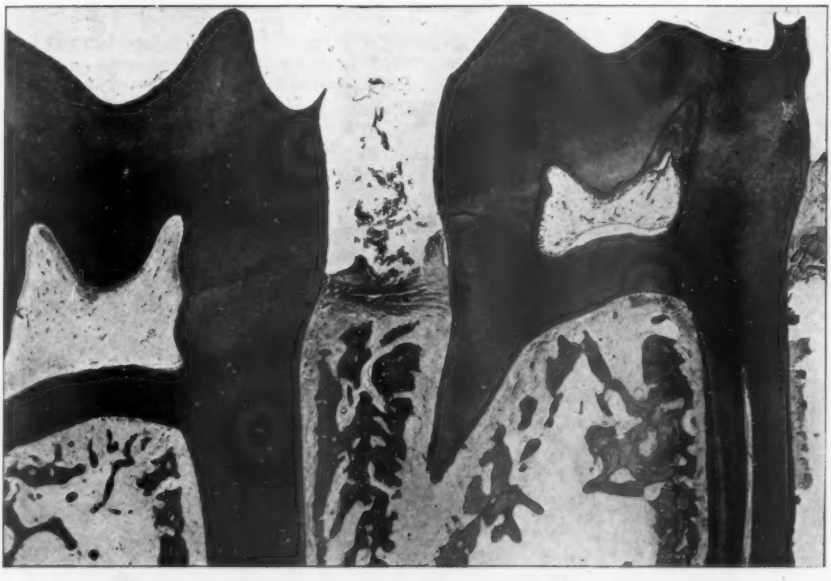


FIG. 7.—Case 2 (73). Raised fillings in 764|. Duration thirteen weeks. Greatest stress on 6|. All cavities very shallow. General view of 76|. In 6| the subgingival epithelium (E.) shows the typical pathological changes of parodontal disease and the pulp shows degenerative changes. In 7| these tissues appear practically normal, the tear in the subgingival epithelium being an artefact. × 10.

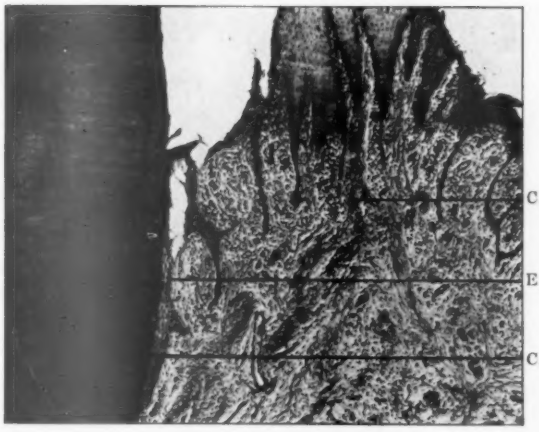
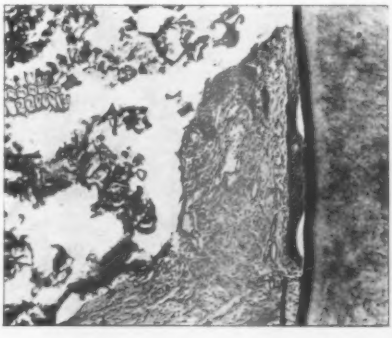
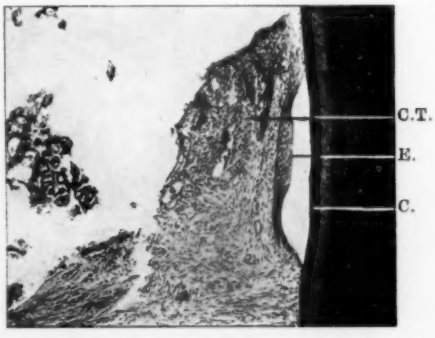


FIG. 8*a*.—Higher magnification of fig. 7. 6 | medial gingival sulcus. × 65.





FIGS. 8*b* and 8*c*.—Higher magnification of fig 7. 6 | distal gingival sulcus. × 65. Figs. 8*b* and 8*c* are from two different sections of distal side of 6 | . All three sections show proliferation of the subgingival epithelium (E.) along the cementum (C.) and into the underlying connective tissue (C.T.). The latter is infiltrated with lymphocytes and plasma cells. Figs. 8*b* and 8*c* show progressive stages in the formation of a pocket. In fig. 8*b* the proliferated epithelium is partly attached to the cementum, though not so firmly as in 8*a*. In fig. 8*c* it has completely split away from the tooth, thereby forming a pocket.

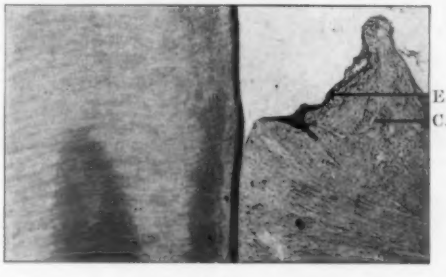


FIG. 9.—Case 2 (73). | 6 distal. Untreated side. Compare with 6 | figs. 8*b* and 8*c*. The subgingival epithelium (E.) and underlying connective tissue (C.T.) are practically normal. × 65.

Case 3 (323).

Experiment : $\underline{6}|$ raised cement filling.
$\underline{7}|$ Raised amalgam filling (greatest stress).
$\underline{8}|$ Raised amalgam filling.
Duration twenty-eight weeks.
Maxillary sections cut mediodistally.
Mandibular sections cut faciolingually.

Result : $\underline{7}|$ Typical pathological changes of early parodontal disease (figs. 10, 11*a*, and 11*b*).
$\underline{6}|$, $\underline{8}|$ unaltered.
$|\overline{7}$ Control is normal.
$\overline{8}|$ Slight pathological changes.
$\overline{67}|$ Unaltered.

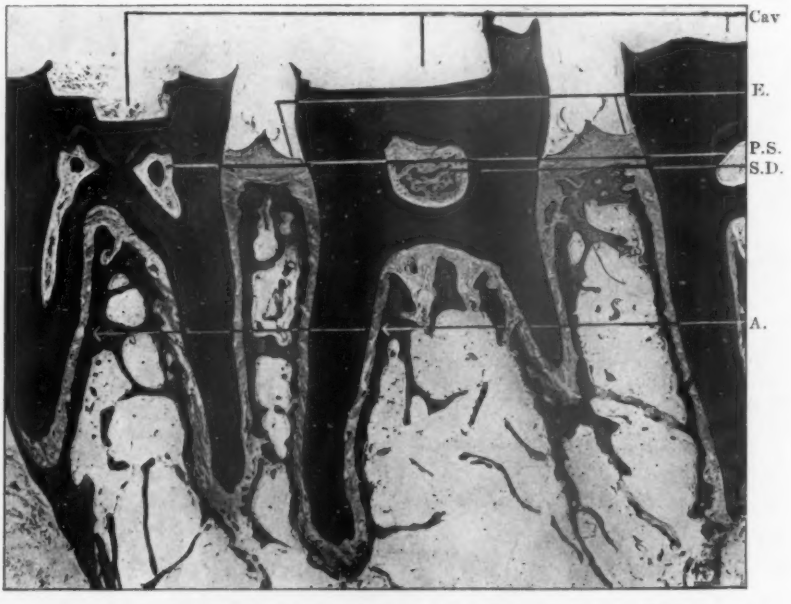


FIG. 10.—Case 3 (323). Raised fillings in $\underline{6}|$, $\underline{7}|$ and $\underline{8}|$. Greatest stress on $\underline{7}|$. Duration twenty-eight weeks. General view. The cut cavities (Cav.) are observed. $\underline{7}|$ is the only tooth that shows pathological changes in the subgingival epithelium (E.). In $\underline{6}|$ and $\overline{7}|$ the alveolus (A.) is irregular and in $\underline{6}|$ it is sclerosed. All pulps contain secondary dentine (S.D.) and $\underline{6}|$ also shows two pulp stones (P.S.). × 10.

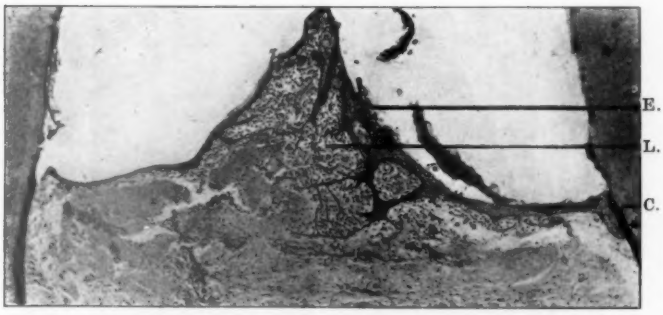


FIG. 11*a*.—Higher magnification of fig. 10. Gingival sulcus of $\underline{6}|$ and $\underline{7}|$. × 65.

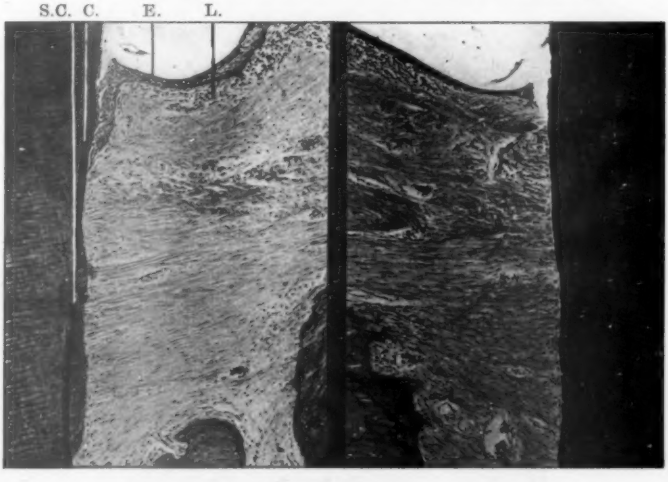


FIG. 11*b*.—Higher magnification of fig. 10. Gingival sulcus of $\underline{7}|$ and $\underline{8}|$. × 65. Figs. 11*a* and 11*b*. In $\underline{6}|$ and 8 | the subgingival tissues are practically normal while in $\underline{7}|$ on both medial and distal sides they have undergone pathological changes. On the medial side there is proliferation of the subgingival epithelium (E.) into the underlying connective tissue and along the cementum (C.). The latter condition is also observed on the distal side and below is a new layer of secondary cementum (S.C.). The connective tissue on both sides of $\underline{7}|$ is infiltrated with lymphocytes and plasma cells (L.).

Case 4 (*12/35*).

Experiment: $|\overline{5}$ Raised amalgam filling.
$|\overline{6}$ Raised amalgam filling (greatest stress).
$|\overline{7}$ Raised cement filling.
Duration forty-three weeks.
All sections cut faciolingually.

Result: $|\overline{6}$ Certain pathological changes of parodontal disease (fig. 12).
$|\overline{57}$ Unaltered.
$|\overline{6}$ Slight pathological change on lingual aspect only (fig. 13).
$|\overline{5}$ Unaltered.
$|\overline{7}$ Spoilt when sectioning.

FIG. 12.—Case 4 (12/35). Raised fillings in ⌊ $\overline{567}$. Greatest stress on ⌊ $\overline{6}$. Duration forty-three weeks. Lingual gingival sulcus of ⌊ 6.

FIG. 13.—Case 4 (12/35). Raised fillings in ⌊ $\overline{567}$. Greatest stress on ⌊ 6. Duration forty-three weeks. Lingual gingival sulcus of ⌊ $\overline{6}$. × 65. $\overline{6}$ ⌋ and ⌊ $\underline{6}$ (figs. 12 and 13) are the only two teeth to show any pathological change in the subgingival tissues and here it is only slight. There is proliferation of subgingival epithelium (E.) along the cementum (C.).

Case 5 (96/34).

Experiment: |5 Raised amalgam filling.
|6 Raised amalgam filling.
|7 Raised cement filling.
Duration thirty weeks.
All sections cut faciolingually.

Result: |5 Slight pathological change on facial side only.
|67 Unaltered.
5| and |567 Spoilt when sectioning.

FIG. 14.

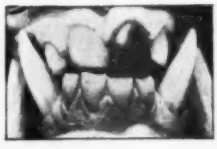


FIG. 15.

FIGS. 14 and 15.—Case 6 (37). **Fig. 14: Alignment of teeth before experiment. Fig. 15: Raised crown on | 1. Duration ten weeks. The alignment of | 1 is not grossly altered but the opposing | 12 are depressed. Compare the puckered gingiva of | 12 with that of the control 21 |.**

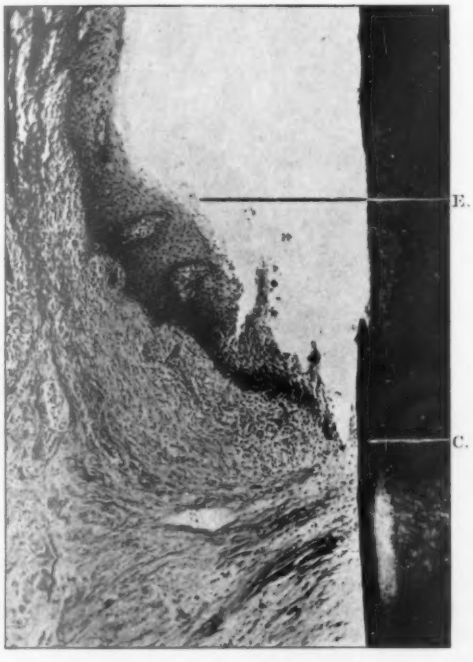


FIG. 16.—Case 6 (37). **Raised crown on | 1. Duration ten weeks. In | 1 lingual sulcus there are thickening and proliferation of the subgingival epithelium (E.) along the cementum (C.) which is torn on sectioning and also into the underlying connective tissue. The latter is infiltrated with lymphocytes and plasma cells** × 70.

Case 6 (37).

Experiment : |1 Raised crown.
Duration ten weeks.
Sections cut faciolingually.

Result : The alignment of |1 is not grossly altered, but the opposing teeth in the mandible $\overline{|12}$ are considerably depressed (cf. figs. 14 and 15).

|1 Pathological changes of parodontal disease only on the lingual surface (fig. 16).

1| Control. Lingual surface also shows slight pathological changes, but is more normal than |1 (fig. 17).

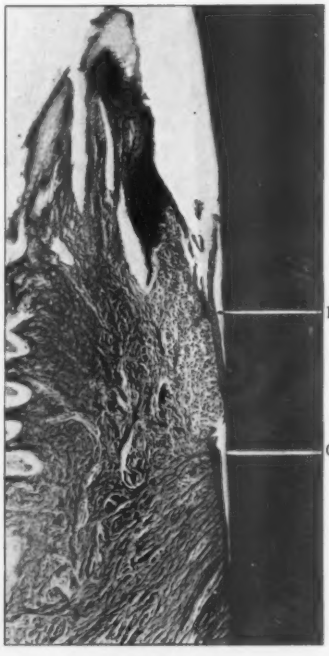


FIG. 17.—Case 6 (37). 1| control. Here the attachment of the subgingival epithelium (E.) to the cementum (C.) is almost normal. The latter is torn on sectioning from the dentine. There are very few inflammatory cells. × 70.

Case 7 (345).

Experiment : $\overline{6|}$ Raised amalgam filling.
$\overline{7|}$ Raised amalgam filling.
$\overline{8|}$ Raised cement filling.
Duration twenty-one weeks.
All sections cut mediodistally.

Result : Wandering of the teeth is observed as is shown by the difference in the centres of the maxillary and mandibular incisors.

In all teeth the epithelial attachment to the cementum appears practically normal. It shows a certain tendency to proliferate into the underlying connective tissue. The latter is infiltrated with inflammatory cells.

Discussion and Conclusions

Reviewing the experiments on the seven monkeys which have just been detailed, it is seen that the following results are obtained :—

In three cases (Nos. 1, 2, and 3) very definite changes in the tissues immediately underlying the gingival sulcus are produced which are analogous to parodontal disease (figs. 1–6, 7–9, and 10–11*b*).

In three cases (Nos. 4, 5, and 6) less extreme pathological changes are seen (figs. 12, 13, and 14–17).

In one case (No. 7) there is no change.

Of the 39 teeth subjected to trauma by raised fillings or opposing the latter, 11 showed pathological changes in the subgingival tissues.

With regard to the three cases (Nos. 1, 2, and 3) in which the definite changes of early parodontal disease have been produced, the sections prepared from them show some interesting results.

In Case No. 1 (figs. 1 and 2) raised fillings were inserted in |567. The greatest stress was on |6, and this is the only tooth in the maxilla to show definite changes indicative of parodontal disease. 6| the control tooth on the opposite side is normal and hence from this, it can be concluded that |6 was also normal, before the experiment (cf. figs. 3*a*, 3*b*, with fig. 4). In the same case in the opposing mandibular teeth, again in |6 extreme pathological changes are seen in the subgingival tissues. This is not observed in |7 (figs. 5 and 6).

In Case No. 2 (fig. 7) raised fillings were inserted in 764|, the chief stress being on 6|. It is noted that this again and 6| the opposing tooth, are the only ones to show the changes of parodontal disease. |6, the control tooth on the opposite side, is practically normal (cf. figs. 8*a*, 8*b*, 8*c* with fig. 9).

In Case No. 3 (fig. 10) raised fillings were inserted in 876|, the greatest stress being on 7|. 7| is the only tooth to show the indications of parodontal disease which are better seen in higher magnifications (figs. 11*a* and 11*b*). |7, the same tooth on the opposite side is normal, but is not illustrated as the section was cut faciolingually and hence is not an exact comparison. In the mandible 8| alone shows any pathological change.

It is interesting to note that in spite of three teeth having been subjected to increased stress, in those cases where the condition similar to early parodontal disease has been produced this is practically always confined to the one subjected to the greatest stress and to the tooth with which it articulates in the opposing jaw.

When considering the practical implications which may be drawn from these experiments, it must be remembered that the longest one was of only forty-three weeks' duration and that marked changes were seen in thirteen weeks (figs. 7–9). Now in man the time factor may be increased at least ten or twentyfold and it is obvious that the longer the undue stress, the greater is the possibility of harmful sequelæ. In view of this it can be realized that as a result of the continued irritation, the epithelial proliferation along the cementum just described may continue to progress downwards. This is the precursor of pocket formation, because this epithelial attachment is much weaker than that of the connective tissue to the cementum. An examination of sections shows that in the process of preparation when they are being cut, if any part tears away from the outer surface of the tooth, it is practically always in the first place the epithelium and not the more firmly attached fibres of the

periodontal membrane (figs. 8*b* and 8*c*). Further it is observed that if there is only a partial tear of the epithelial attachment this is nearly always at the part adjoining the sulcus (figs. 12 and 13). Hence as the epithelium proliferates along the cementum there is the tendency for it to become detached from the latter, the tear starting at the gingival sulcus and thereby forming a pocket.

With regard to the type of parodontal disease that might be expected to be a sequel of traumatic occlusion: As in these experiments there was nearly always only one tooth affected, together with the opposing one in the other jaw, it can reasonably be assumed that in man the result is the variety in which there is vertical pocket formation affecting only one or a varying number of teeth.

Parodontal disease is most frequently seen in middle age in connexion with which the angle of the mandible becomes more obtuse (Karolyi, 1901). This is a factor which should be considered, for as a result of this increased obliquity there will be a gradual tendency for the direction of stress on the articulating surfaces to be altered, in other words, the condition will progress to traumatic occlusion.

Again, the condition is, on the whole, more frequently seen in cases of closebite where, in certain movements of the jaws and particularly in lateral movements, the chief stress is taken by one or two teeth. On the other hand, in cases of pre-normal occlusion with an edge-to-edge bite the gums frequently appear healthy even if a number of teeth have been extracted, and in these cases in middle age the teeth show signs of attrition. Due to this flattening of the cusps there is not so much undue lateral stress in this type of occlusion. Should, however, the teeth not wear down, there is then an increased tendency for the gums to be unhealthy.

Another frequent sequel of traumatic occlusion is seen following the extraction of the first molar tooth at an unsuitable time, with subsequent tilting of the second molar. It is known that when circumstances necessitate the removal of the former tooth this should be performed either before 9 years of age or after the second molar is fully erupted and in occlusion. If it is extracted shortly before the second molar has erupted or before the latter is in complete occlusion, the above-mentioned untoward result occurs. In these cases there is nearly always a pocket on the medial side of the latter tooth but this pocket may be partly the anatomical result of the tooth tilting, as well as due to traumatic occlusion affecting the subgingival tissues.

In conclusion it is felt, after considering the above experimental and clinical data, that traumatic occlusion is a predisposing factor in the production of parodontal disease and particularly in the type where isolated or a varying number of teeth are affected, with vertical pocket formation. It should be diagnosed and, if possible, treated in all mouths, irrespectively, whether gingival infection is present or not. Particular attention should be paid to relieving those cases where the fossa between the cusps is deep, so that the teeth when closed are firmly interlocked, for in lateral movements of the jaw, if there is any slight abnormality, extreme stress may be placed on several teeth in the harmful horizontal direction. It must, however, be realized that traumatic occlusion is not the only cause of the disease. Further it is observed that patients exhibiting this abnormality are seen, in whom there is no gingival infection or loosening of the teeth. In these cases the latter appear very firmly implanted and on radiographic examination the alveolus is seen not to be rarefied, indicating that the tissues have reacted favourably to the increased stress as opposed to the type of case in which parodontal disease develops with concomitant movement of the teeth and an increased radiolucency of the alveolar crests. In the experiments under present discussion it was observed in the case in which the gingival sulcus was unaffected, that the alveolus surrounding the traumatized teeth was much sclerosed. This opposing reaction of the gingival

tissues and underlying bone to increased stress may thus be associated respectively with increased deposition or removal of calcium from the alveolus.

[The writer wishes to express his gratitude to the Medical Research Council and the Dental Advisory Committee, who have made this investigation possible by means of a grant for expenses.]

BIBLIOGRAPHY

Box, H. K. (1928), "Treatment of the Periodontal Pocket", University of Toronto Press.
Id. (1935), *Oral Health*, Toronto, **25**, 9.
Bunting, R. W. (1937), "Oral Hygiene and the Treatment of Parodontal Diseases", Philadelphia.
Fish, E. W. (1935), *Brit. Dent. J.*, **58**, 531 and 602.
Gottlieb, B., and Orban, B. (1931), "Die Veränderungen der Gewebe bei übermässiger Beanspruchung der Zähne", Wien.
James, W. W., and Counsell, A. (1927), *Brit. Dent. J.*, **48**, 1237.
Karolyi, M. (1901), *Oest. Ung. Vierteljschr. Zahnheilk.*, **17**, 279.
Kronfeld, R. (1933), "Histopathology of the Teeth and their Surrounding Tissues", Philadelphia.
Stillman, P. R., and McCall, J. H. (1922 and 1937), "A Textbook of Clinical Periodontia", New York.
Stones, H. H. (1932), *Brit. Dent. J.*, **25**, 6, 886.

Discussion.—Mr. T. W. E. Pugh: It is not possible to accept without reserve the statement that "deep fissured teeth are particularly liable to traumatic occlusion". American opinion is strongly opposed to this view. American odontologists advise deep contouring of all fillings in teeth showing traumatic strain, maintaining that point contact obtained thereby lessens the stress and increases chewing efficiency.

The experiment of crowning a sheep's incisor is unconvincing, for these teeth have no opponents.

Mr. M. A. Rushton said that in one part of his paper Professor Stones seemed to suggest that the reason why persons with much attrition did not show vertical pocketing was that there was no cusp interlock. Was not this putting the cart before the horse? They showed attrition because the bone had been sclerosed and prevented tooth movement. In another place he appeared to admit that the reaction of the connective tissues to severe masticatory stress might take the form either of vertical pocket formation or of sclerosis. Had he made any observations on the physique of the monkey which, unlike all the others, showed the sclerotic reaction?

Professor Stones (in reply) pointed out that a very deep fossa between the teeth caused most damage in middle life when the occlusion was abnormal. In teeth showing traumatic strain he did not think it advisable to overdo the contact with the occluding tooth. On the other hand maintaining good contact between interproximal fillings was of course beneficial.

Box realized that the sheep's incisor was in contact only with a pad of gum!

With regard to teeth with much attrition not being so susceptible to pocket-formation, he still felt that this was largely due to the type of occlusion, as this condition was mostly observed in cases of edge to edge bite.

In the monkey showing marked sclerotic reaction of the alveolus, he had not observed any unusual physical condition.

The Relation of the Deciduous and Permanent Molars in the Ox

By Alvan T. Marston, L.D.S.Ed.

A divergence of opinion is expressed among dental anatomists as to whether the teeth which we ordinarily term the permanent molars do in fact belong to the second dentition, or whether they should be regarded as deciduous teeth which erupt late. In "Meyer's Histology and Histogenesis of the Human Teeth", translated and edited by Herman R. Churchill, 1935, the latter view is favoured.

In the specimen—the mandible of an ox—which is exhibited to-night, the second deciduous molar has three pillars or cusps. This is the normal condition. Behind this come the three permanent molars, the first and second each with two cusps and the third with the reappearance of the third cusp. Although this particular specimen does not illustrate the full development of the third cusp of the third molar so well as do the other ox mandibles which are on view, it is well known that the third permanent lower molar of the ox does have three cusps.

Attention is called to the following points :—

(1) That a distinct break in the morphological continuity occurs behind the second deciduous molar.

(2) This tooth, which may be considered brachyodont with three cusps, is followed by hypsodont molars, the first and second with two cusps and the third with three cusps.

(3) The second deciduous molar when shed, is succeeded by a premolar tooth which is in harmonious serial homology with the permanent molars.

On this evidence, are we not justified in maintaining that the three-cusped second deciduous molar is the end tooth of the deciduous series, and that the three permanent molars are not deciduous molars which have erupted late, but are in serial homology with the other permanent teeth, the anterior and cheek teeth ? Moreover, since the brachyodont condition is to be considered as more primitive than the hypsodont, does not the distinction between the brachyodont deciduous and the hypsodont permanent molars show the two series in their true developmental relationship ?

An analogous break in the morphological continuity affects the human dentition in respect to crown height, cervical contraction, divergence of the roots, and infilling of the median fossa ; the permanent molars being further evolved than the deciduous teeth.

Section of Comparative Medicine

President—S. P. BEDSON, M.D., F.R.S.

[*January* 26, 1938]

Epizootic Adenomatosis of the Lungs of Sheep: Its Relation to Verminous Pneumonia and Jaagsiekte

By NIELS DUNGAL

Professor of Pathology, University of Reykjavik

FOR some years we have had in Iceland a disease raging among sheep, causing an average loss of 50 to 60 per cent. in affected flocks in the course of one or two years.

Origin of the disease.—The disease originated on one farm and spread excentrically from there. On this farm was a ram of Karakul breed which had been imported from abroad, and the two sheep which shared a compartment with the ram during the winter of 1934 were the first of the home stock to be affected after the ram had disappeared in sick condition to the mountains, never to come back.

In the autumn of 1934 great losses, which have been going on ever since, began in the stock on this farm. Meanwhile the disease has been spreading from one farm to another in the neighbourhood, the spread of infection being facilitated by the large collections in autumn, when sheep from a great number of farms meet in the big common folds.

Clinical symptoms.—The disease is chronic and the initial symptoms are slight and unnoticeable, so that several sheep may be affected in a flock without showing any obvious change. Perhaps the first symptom to attract the trained observer's attention is an occasional cough in a hitherto healthy sheep. Eventually there may be an attack of spasmodic coughing after exertion. In the initial stage the sheep will show no symptoms when at rest, but after being driven for some distance it may get out of breath, and this dyspnœa may continue for one or two hours after the other sheep have been breathing normally.

Auscultation will reveal moist râles somewhere in the lungs, particularly in the lower region. According to our experience the most reliable signs are the moist râles, which in an advanced case can be heard many yards away, and the great increase in bronchial secretion, which is best demonstrated by inclining the head of the animal to the ground and watching the white, frothy, thin fluid, which drops or streams out of the nostrils. This is considered to be the pathognomonic symptom of adenomatosis, as we have never found it in a sheep which was not affected with this condition.

After the appearance of these symptoms the disease may go on for weeks and months, and we know of cases in which the sheep have been sick for over a year. We have found no fever before the final stage, when the animal frequently dies from a terminal pneumonia, which is accompanied by a rise in the temperature. The animal will keep its appetite for long periods, and there may be no appreciable loss in condition. But if the disease runs a protracted course, emaciation may be extreme, accompanied by anæmia, which, however, rarely becomes severe. Recovery occurs so rarely, that most farmers kill the sheep as soon as they show definite symptoms.

Incubation period.—In a number of cases we have obtained reliable records of the source of infection and the space of time between exposure to infection and appearance of symptoms. The usual period of incubation is six to eight months. A typical case is the following : A ewe from an infected district was found far away, where nobody suspected the disease. This sheep was sold to a farmer, who took it with him, stopping at a neighbouring farm, where the sheep was kept for two days and nights in a small compartment with four lambs. When the owner killed the ewe a fortnight later he noticed that the lungs were large and unhealthy-looking.

All the four lambs fell sick, but no sign of disease was observed until after nine months in the first lamb, and after eleven or twelve months in the last. These lambs had, so far as was known, no possibility of contact with sick sheep except during the two days when they were housed with the sick ewe.

Age-incidence.—Sheep of all ages seem to be affected, no age-period being exempt, but the disease is rarely seen in lambs less than 7 months old. After that age the mortality rate increases, and farmers who for two years or more have been struggling with the disease, usually kill all their lambs in the autumn in order to avoid losing them during the winter and spring.

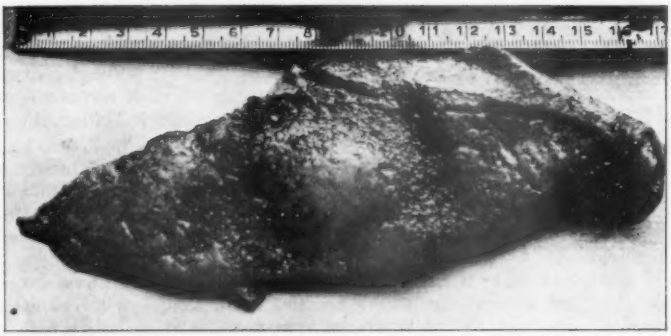


FIG. 1.—Initial lesion, hard and fibrous in the middle, with surrounding nodular tissue.

The question arises as to whether the disease is congenital. A few records from reliable farmers point strongly in this direction. In one case, for example, a newborn lamb was seen to get out of breath each time after suckling, and to avoid movements, and fluid was seen pouring out of its nostrils. We have never had the opportunity of examining such cases, which seem to be rare.

Morbid anatomy.—The initial lesion (fig. 1) may occur anywhere in the lungs. It may be as small as a cherry or as large as a hen's egg, and is frequently situated immediately under the pleura, though it may occur anywhere in the substance of the lung. It is not very distinctly limited, and the cut surface is greyish and is composed of numerous more or less elevated small nodules, usually 2–5 mm. in diameter. In fresh cases apparently sound tissue may be seen between the slightly elevated nodules, but as the disease advances, more and more nodules seem to be formed, until they are so closely set that no sound tissue can be distinguished between them. Around this lesion small, dispersed, greyish, slightly protruding nodules may be seen, decreasing in size and number with increasing distance from the chief lesion. In advanced cases large areas of the lungs are transformed into greyish, nodular, friable tissue, which breaks down easily between the fingers. In fairly recent cases it is often more or less waterlogged, whereas older lesions tend to show fibrous

changes, so that the initial lesion may be fibrous, whitish, and hard, when all other lesions are still soft, œdematous, and friable. A mucous, whitish, frothy fluid flows from the bronchi, the mucosa of which shows no apparent changes.

The enlargement of the lungs is usually striking (fig. 2), sometimes enormous, especially in cases of longer standing. This is chiefly the result of enlargement of the affected parts, which present considerable emphysema and increased water content, but in many instances a generalized enlargement of the lungs has been observed, in which lesions were only few and scattered, as if this general emphysema might be the first stage along with only small and scattered consolidations. The lymph-glands are not enlarged, except in cases complicated by pneumonia. The pleura is frequently affected, and covered by a thin membrane, which may cause adhesions between the lobes and the thoracic wall. In other organs no particular changes are seen.

FIG. 2.—Showing great enlargement of an affected lung as compared with a normal lung.

Histology.—The histological picture is most characteristic. The sections may be picked out with the naked eye, showing intensely coloured patches with clear spaces between. The microscope reveals the dots as islands of epithelial proliferations, resembling adenomatous nodules (fig. 3). Not only are the alveoli covered with high columnar epithelium, but large, branched papillæ of loose connective tissue are formed, covered with a more or less regular layer of high columnar epithelium. Outside these epithelial nodules small tufts of epithelium may be seen in some alveoli. But apart from that the surrounding lung tissue is well filled with air, the alveoli are frequently wider than normal, and the septa may be very thin, so that no capillaries may be demonstrable in them. A greater or smaller amount of what appears to be desquamated respiratory epithelium is seen in the alveoli, and small groups of segmented leucocytes are usually seen somewhere in the alveoli and also in the connective strands of the epithelial papillæ.

As the disease advances, the epithelial tissue appears to proliferate, early epithelial alveolar proliferations growing up to solid adenomatous nodules (figs. 4 and 5), the growth evidently beginning in many alveoli simultaneously. In some alveoli the proliferations will be greater than in others, forming large papillary tufts which expand and break the alveolus in which they originated.

The epithelial proliferations apparently originate in the alveoli, thus furnishing an argument in the long-standing controversy on the nature of the alveolar lining, which here seems to react by desquamating the normal cell-lining and then rapidly to produce cylindrical, epithelial cells. These alveolar cells contain no cilia; on the other hand, cilia may be demonstrated in the bronchi, where papillary tufts are not infrequently seen projecting into the lumen. It will be easily understood that when this tissue has replaced a great proportion of the total lung, respiration must be considerably impaired.

Course of disease.—We know of no instance in which sporadic cases have not been followed by heavy losses, except when special measures have been taken by immediately isolating sheep coming from diseased flocks. The course on a farm is usually as follows: On a hitherto healthy farm a sheep is noted to be sick in the late winter or early spring (March-May). There may be one or two such cases, but the rest of the

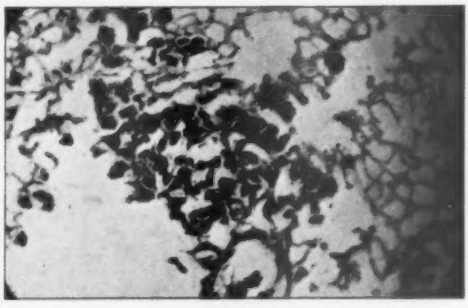


FIG. 3.—Adenomatosis. Low-power view of adenomatous nodule.

flock remain perfectly healthy throughout the summer, until the following autumn, when, after a time corresponding to the time of incubation, great losses inevitably begin. From this time onwards there are continuous losses, new cases appearing weekly. In January and February few new cases occur, a fact which is probably explained by the rare contacts during summer, when the sheep are at free range. In April, May, and June, the losses begin again and continue without interruption throughout the summer, until 50 to 60 per cent. are lost. The losses may reach 80 per cent. and more, and some farmers have slaughtered all their flock.

Resistance and immunity.—Different breeds show marked difference in resistance. One common breed, which is widely spread over the country, has proved particularly susceptible, 90 per cent. and even more having been lost on many farms. No absolutely resistant breed has been found, and only one seems to be fairly resistant. About 10 per cent. of this breed is lost, but as the strain is very rare the numbers are small and do not permit of conclusive deductions.

Ætiology.—This is unknown. No bacteria are found in the lesions, and cultures are negative, even though prepared on different kinds of media and incubated aerobically and anaerobically and with different carbon-dioxide-tensions. We have also tried virus cultivation on the chorion-allantoic membrane of hens' eggs, but with negative results. Transmission has been easily effected by keeping healthy and sick sheep

housed together, but by pulmonary injection of unfiltered material it was positive only in one case out of three. Attempts to set up the disease in five cases with Seitz-filtered material gave negative results.

Comparison with other known diseases.—McFadyean [1 and 2] has described a similar disease found in England about fifty years ago. Finding numerous nematodes of a species to which he refers as *Strongylus rufescens*, in and particularly around the lesions, he ascribed the disease to this parasite. Since his publication numerous authors have reported on verminous pneumonia, but the helminthological side of the

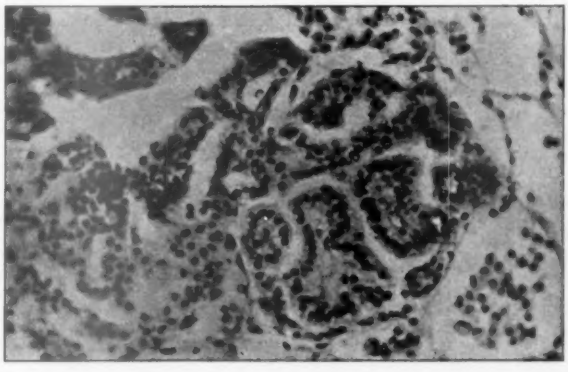


FIG. 4.—Adenomatosis of sheep's lung. Small adenomatous nodule surrounded by alveoli containing desquamated epithelial cells.

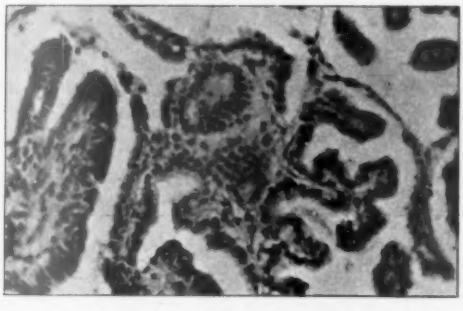


FIG. 5.—Formation of high papillæ in an adenomatous nodule.

question will be dealt with more adequately by Mr. Taylor. In short, we found the same anatomical lesions that McFadyean had associated with parasitic lungworms.

Comparing our findings with the descriptions given by Mitchell [3], Cowdry [4], Cowdry and Marsh [5], and de Kock [6], we incline to the opinion that our disease is identical with Jaagsiekte. The symptoms of our disease are the same as those described by the South African authors—the protracted course, dyspnœa, and nasal discharge—and the farmers there use the same method for diagnosis, namely, to incline the head of the animal to the ground and observe the fluid dropping from the nose. The terminal pneumonia is, according to de Kock, a very frequent feature. The lesions, as described by Cowdry and de Kock, are indistinguishable from our

findings, there being the same islands of epithelial proliferations and desquamation of round cells into the surrounding alveoli (fig. 6). The only histological difference which we find is a less interstitial reaction than that described by the South African authors, and the small nodules of connective tissue, described by McFadyean and Cowdry, are not apparent in our cases. Mitchell assumes the incubation period of Jaagsiekte to be from three to eight days, but, as de Kock has shown, it is very difficult in South Africa to obtain material which is certainly free from the disease, so that a typical Jaagsiekte lesion found a week after contact is just as likely to have been present before the contact.

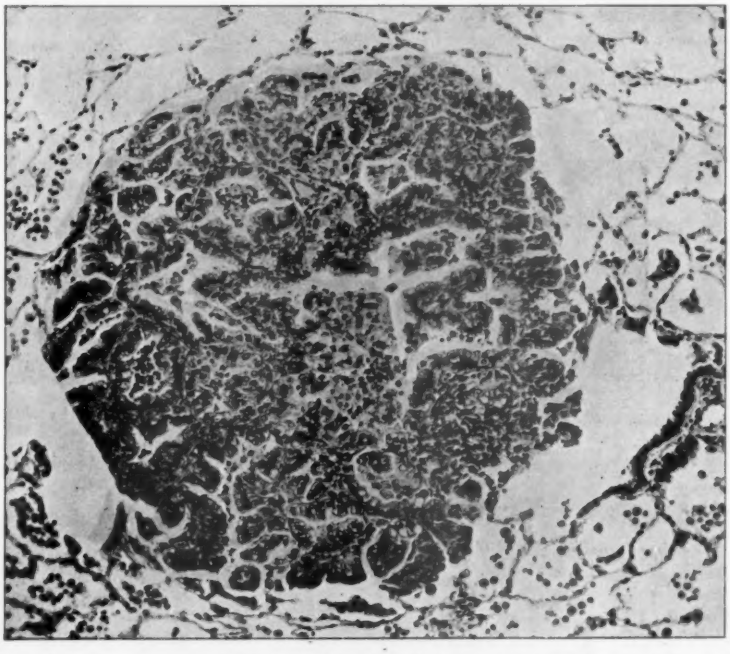


FIG. 6.—Adenomatous nodule from a section of Jaagsiekte (kindly sent by Professor Cowdry).

Cowdry and Marsh (l.c.) compared the progressive pneumonia of Montana with Jaagsiekte, and found many features of resemblance between the two, concluding that they are probably identical. Professor Cowdry has kindly sent me sections of his material for comparison, and from these sections we concluded that Jaagsiekte and our disease were probably the same, whereas the histological changes in the progressive pneumonia seemed to us to have rather the character of a chronic bronchopneumonia, the epithelial proliferations being slight or negligible, although a considerable desquamation of the alveolar epithelial cells is to be seen. We would not deny the possibility that the progressive pneumonia might belong to the same category, but, in our opinion, the histological changes hardly justify the assumption that progressive pneumonia is identical with Jaagsiekte. We have seen one or two similar cases on infected farms, but have not made a definite diagnosis of adenomatosis on that histological finding, whereas the sections of Jaagsiekte which we have seen correspond exactly with our histological findings.

The objection may be made, that the epithelial proliferations are only a secondary phenomenon which may follow any chronic pathological process in the lungs. We have considered this possibility and have had lungs sent for comparison from all parts of the country. The two chief lung diseases which we found were contagious pneumonia and heavy *Muellerius* infestation. In these lungs we have never found changes which resembled adenomatosis, and we are convinced that the adenomatous disease is a disease *sui generis*, which can always be traced to a known source of infection.

Our opinion is, therefore, that Jaagsiekte and our disease are the same. The difference in mortality, which is much higher in Iceland than in South Africa, is probably explained by the difference in treatment. The sheep in South Africa are always grazing freely, and only rarely collected in kraals, whereas our sheep are housed for a long period in winter and thereby have far higher chances of infection. The South African authors, and Cowdry in America, point out the histological resemblances between Jaagsiekte and verminous pneumonia, but all agree that Jaagsiekte cannot be of helminthic origin, as no worms have been found in connexion with that disease, and apparently lungworms are very rare in South Africa. We incline therefore to the opinion that Jaagsiekte, the verminous pneumonia recorded by McFadyean, and our disease are all the same and are caused by some infective agent, the nature of which it has not been possible to demonstrate.

Adenomatosis in man.—Several cases are mentioned in the literature of adenomatous changes in human lungs. I shall only mention a few which resemble our cases of sheep disease.

Oberndorfer [7] describes a condition in an old woman, in which, besides a pneumonia, multiple adenomatous nodules were seen in the lungs, the alveolar epithelium being changed to cubical or cylindrical epithelium, forming papilliferous ingrowths into the alveoli. Metastatic growths were found in the bones and a diagnosis of lung cancer was therefore made. Oberndorfer says he had the impression that a rapid epithelial proliferation followed the transformation of the alveolar epithelium. "In our case", he says, "one could speak of multiple, beginning adenomas in the lung alveoli." Helly [8] describes a case of an old woman who had been suffering for a year from what was thought to be phthisis, and died suddenly. Multiple adenomatous nodules were found post mortem, with emphysematous tissue between. The description of the macroscopic and microscopic appearance of the lungs corresponds very nearly with the adenomatosis in the sheep. Löhlein [9] describes a similar case which he declared to be identical with Helly's, and at a congress in Germany Saltykow and Sternberg described the same kind of tumours at autopsies.

In Iceland we have seen no human cases which resembled the sheep disease and have found no evidence that it might be communicable to man. The occurrence of a similar condition in man shows that no worms are needed to produce such changes, for no nematodes are known as parasites of the human lungs. Aynaud [10] has suggested that the mere passing of worm larvæ through the lungs might be sufficient to start the adenomatous proliferations, as he found no lung worms in some of his cases, but only *Ancylostoma* in the small intestine. This suggestion is not corroborated by facts, as we do not know of adenomatous changes or cancer in the human population where ancylostomiasis or ascariasis is common.

Is the sheep disease a tumour growth? De Kock [6 and 11] has suggested that Jaagsiekte is a neoplastic process, and in fact there are many resemblances. When metastatic nodules are seen in lymphatic glands, as reported by Aynaud, the neoplastic nature of the process cannot be questioned. But Aynaud's is the only case reported in which metastasis has been found. Professor Peyron has given me the opportunity of studying Aynaud's sections, which showed undoubted metastasis in a lymph-gland, the epithelial proliferations having a papilliform or gland-like structure

among the remaining lymphatic tissue, which was, to a great extent, destroyed. In some of our cases we have found nodules up to the size of an apple composed like a pure cystadenoma, of numerous, large papillæ recalling the intraduct papilloma of the mammary gland in humans. The question whether Jaagsiekte and our disease may be regarded as neoplastic in nature may be discussed, but in my opinion only unprofitably so long as we do not know the cause of either. Aynaud, Peyron, and Falchetti [12] who have investigated numerous cases of presumed verminous origin in France (parasites were absent in half of their cases), come to the conclusion that the process is a real tumour growth. The histological changes seem to me to point to some agent which simultaneously has an effect upon a vast surface of the respiratory epithelium, transforming it to high, columnar form, thereby giving the newly formed epithelium a stimulus for continued growth. The growth starts simultaneously in numerous centres after the initial lesion has appeared, as if infectious material was spread from the initial lesion through the lung tissue, and since the lower borders are particularly affected it appears as if the infected secretion from the affected parts sinks to the lower parts of the lungs, there to produce fresh changes. This is not the usual process of tumour growth, although the microscopic appearance may greatly resemble it ; evidently we have here a process which may be of great interest for tumour research, as there is a factor at work with a definite organizing power, which greatly stimulates the growth of certain tissue cells.

Conclusions

Comparing the so-called verminous pneumonia with our disease in Iceland, and with Jaagsiekte, we find histological changes of a very specific nature, which point to a specific origin. The South African authors deny the possibility that Jaagsiekte is caused by helminths, and we cannot find any correlation between lungworm infestation and our sheep disease.

The sections which Prof. Peyron showed me from his own and from Aynaud's cases are histologically also identical with ours.

We therefore think that the adenomatous changes, which in the literature are described as a result of worm infestation, are caused by some factor yet unknown, and cannot be explained by the action of worms alone. Whether the worms may play an intermediary part cannot yet be determined, but we at least have no reason to believe that they do.

It will be seen that we have not proceeded far in our research work. We think we have made a step towards correcting a widespread error with regard to helminthic pathology. But the experimental work with this disease is greatly hampered by the long incubation period, the difficulty of artificial transmission, and the resistance of laboratory animals to the disease. If we could get this disease down on a clear-cut experimental basis, and transmit it artificially to sheep or laboratory animals, it might prove of considerable scientific interest, as we have here a borderline between inflammation and tumour growth.

BIBLIOGRAPHY

1 McFadyean, J., "Verminous pneumonia in the sheep", *J. Comp. Path. and Therap.*, 1894, **7**, 31.
2 Id., "Transformation of the alveolar epithelium in verminous pneumonia in the sheep", *ibid.*, 1920, **33**, 1.
3 Mitchell, D. T., "Investigations into Jaagsiekte or chronic, catarrhal pneumonia of sheep", *Rep. vet. Res. S. Afr.*, 1915, **3** and **4**, 585.
4 Cowdry, E. V., "Studies on the etiology of Jaagsiekte", *J. Exper. Med.*, 1925, **42**, 323 and 335.
5 Cowdry, E. V., and Marsh, H., "Comparative pathology of South African Jaagsiekte and Montana progressive pneumonia of sheep", *J. Exper. Med.*, 1927, **45**, 571.
6 de Kock, G., "Are the lesions of Jaagsiekte in sheep of the nature of a neoplasm?" *Rep. vet. Res. S. Afr.*, 1929, **15**, 611.
7 Oberndorfer, S., "Zellmutationen und multiple Geschwulstentstehungen in den Lungen", *Virchows Arch. f. path. Anat.*, 1929, **275**, 728.
8 Helly, K., "Ein seltener, primärer Lungentumor", *Ztschr. f. Heilkunde*, 1907, **28**, 105.

9 LÖHLEIN, M., "Cystisch papillärer Lungentumor", *Verhandl. d. deutsch. path. Gesellsch.*, 1908, p. 111.
10 AYNAUD, M., "Origine verminеuse du cancer mulponaire de la brebis", *Compt. rend. Soc. de biol.*, 1926, **95**, 1540.
11 DE KOCK, G., "Further observations on the etiology of Jaagsiekte", *Rep. vet. Res. S. Afr.*, 1929, **15**, 1169.
12 AYNAUD, PEYRON, and FALCHETTI, "Sur le cancer du poumon chez le mouton et ses liens étiologiques avec les lésions parasitaires et infectieuses", *Compt. rend. Acad. d. Sc., Paris*, 1932, **195**, 342-344.

The Lungworm Theory for the Origin of Epizootic Adenomatosis and the Question of the Existence of Adenomatosis in Great Britain

By E. L. TAYLOR

Veterinary Laboratory, Ministry of Agriculture and Fisheries

MY experience of this disease has been small in comparison with that of Professor Dungal and Dr. Gislason, and my work on it has been limited to what could be accomplished during a stay of about five weeks in Iceland, and by the examination of a certain amount of material which had previously been sent to this country.

Professor Dungal has mentioned his reasons for believing that parasitic worms were the cause of the trouble. The pathological evidence obtained from the microscopical examination of affected lungs showing the presence of numerous parasitic worms and their larvæ in close association with the diseased tissue, was very suggestive of that conclusion. McFadyean also came to the same conclusion when investigating what appears to have been a similar disease which occurred in this country in 1888.

Some evidence was, however, obtained by Dr. Gislason to suggest that the worms might not be responsible; an examination for worm infestation which was carried out on 1,000 lungs from a diseased district, and on 1,000 lungs from a district in which the disease had not yet appeared, revealed an equal degree of infestation in each district.

On account of McFadyean's publications, however, and also on account of the strong pathological evidence in favour of the theory of causation by lungworms, it became all the more necessary to examine the association of these parasites with particular care.

Investigation in England.—Apart from the examination of sections of lung tissue, which has already been dealt with by Professor Dungal, and of hay suspected by Professor Dungal of carrying large numbers of the larvæ of *Muellerius*, the work at Weybridge consisted of the infection of sheep with lungworm larvæ originating from sheep in the diseased area in Iceland. The hay which was examined was found only to contain a few representatives of the strongyloid larvæ of horses and none referable to species of worms occurring in sheep.

In order to ascertain whether British sheep could be infected by Icelandic lungworms, two badly diseased lungs, heavily infected with *Muellerius*, were sent to Weybridge in ice from Reykjavik. On thawing out, the *Muellerius* larvæ were found to be very active and apparently normal. As many of these larvæ as possible were separated from the lungs and fed to slugs and snails of the species *Agriolimax agrestis*, *Helix aspersa*, and *Cepœa hortensis* between February 24 and March 25. During the third week of April it was ascertained that the snails were carrying the infective larvæ, and they were then fed to two lambs which had been born and reared in the buildings. Eight infected snails were given to lamb No. 949 and 13 to lamb No. 950. *Muellerius* larvæ did not appear in the fæces of the lambs until fourteen weeks later, when lamb No. 950 was slaughtered. Large numbers of the typical hard caseous and calcareous nodules were then found in the lungs, indicating the abortive development of numerous worms, but there was no sign of adenomatosis. The second lamb was

kept in isolation indoors until December 8, when it was slaughtered. At autopsy several centres of infection containing living worms were found, but again there was no sign of adenomatosis.

Investigation in Iceland.—In order to ascertain whether there existed in Iceland a new and more pathogenic species of lungworm, the tails of a number of male worms from affected lungs were examined, but every specimen was found to belong to the species *Muellerius capillaris*, which is the most widely distributed member of this group of lungworms, and the species which occurs most frequently in the lungs of sheep in the British Isles.

Relative concentration of lungworm larvæ in affected and in healthy tissue.—The comparative concentration of lungworms in diseased and in healthy parts of affected lungs was also examined. Portions of tissue of equal weight were taken from diseased and healthy parts of lungs ; the *Muellerius* larvæ contained were collected by mincing and washing the tissue, and the larvæ from the various lots were counted by a dilution technique. No correlation could, however, be found between the extent of *Muellerius* infestation and the presence of the disease. The observation of Professor Dungal that the earlier lesions of adenomatosis usually appear along the ventral margin of the lung is in agreement with this finding, since the worm nodules are normally found in the largest numbers in the dorsal region of the lungs.

Possible mass invasion of the lungs with infective lungworm larvæ.—Yet another possibility to be investigated was that the disease might be due to a mass invasion of fourth-stage lungworm larvæ, and a search was therefore made for them. Portions of affected lungs were minced and numerous larvæ were separated ; a search through many thousands of these under the dissecting microscope, however, did not reveal any but the first-stage larvæ, ready to leave the lung, and no single example of a fourth-stage larva was found. In confirmation of this point, only one intermediate-host snail was found in the fields after careful search. A later and more minute examination of small areas in some of the fields revealed, however, a large number of the eggs of slugs and snails deeply situated in the thick growth of herbage or buried just beneath the surface of the soil. If this state of affairs is typical of the whole of Iceland, the majority of the slugs and snails being killed off during the winter and only the eggs surviving, then infection with *Muellerius* could not occur until the later summer and autumn when slugs and snails seem extremely plentiful—and one would not expect to find fourth-stage larvæ at this time of the year.

Comparison of lungworm infestation in healthy and in diseased flocks.—In the early part of the field investigation samples of fæces were collected from several diseased sheep on various farms, an average being obtained for the output of larvæ per gram of fæces, and comparisons were made with a similar number of samples collected from sheep in flocks which still remained free from the disease. No difference was, however, observed between the lungworm infestation of the two groups. A further series of examinations was made in order to compare the lungworm infestation in flocks with a heavy mortality rate with those in which the mortality rate had been comparatively light, but again no correlation could be found, and we concluded that in all probability the parasitic lungworms played no part in the cause or development of adenomatosis.

The possibility of this disease occurring in Great Britain.—Arising out of this inquiry is the interesting question whether this disease occurs in Great Britain. Similar pathological changes in the lungs of sheep were described by McFadyean in three publications dated 1888, 1894, and 1920, dealing with what was considered to be an outbreak of a severe form of verminous pneumonia. The last publication, in 1920, dealt particularly with the histological changes, and the clear description and photomicrographs which appear in this paper are considered by Professor Dungal, Dr. Gislason and myself, to represent changes which are identical with those occurring in epizootic adenomatosis. That Sir John McFadyean now leans towards this same view is shown by the following quotation from a recent private communication which

he has kindly permitted me to insert here. Referring to the possibility of the disease which he described being identical with Jaagsiekte the letter states :—

" I think at the present moment there may be some difficulty in defining what is to be understood by the term Jaagsiekte, but since Dr. Cowdry agreed that the specimens which I sent him from the lungs of sheep in this country were similar to those observed in South Africa, the disease in the two countries may be regarded as the same. Furthermore, identical lesions were present in sections of lungs of sheep in Iceland sent to me by Prof. Niels Dungal. Personally I do not now think that the remarkable transformation which occurs in the bronchial epithelium can be regarded as a specific reaction to the worm parasites."

In our opinion, therefore, the changes described by McFadyean were not brought about by lungworms but were the typical pathological changes caused by the same disease as is now causing such losses among Icelandic sheep.

We also consider that these pathological changes are identical with those of Jaagsiekte, and that the three conditions which have been described, in Great Britain by McFadyean, in Iceland by us, and in South Africa by Mitchell, de Kock, Cowdry, and others, represent the same disease. The writers on Jaagsiekte, however, did not appear to have considered the possibility of the occurrence of that disease in Great Britain and always referred to McFadyean's description as a standard account of a peculiarly severe kind of verminous pneumonia. If our view is correct—that epizootic adenomatosis or Jaagsiekte has occurred among British sheep—and we are convinced that this is so, there arises the epidemiological question as to whether it has disappeared from this country or whether it may still remain, in a benign form, in some parts. The chronic nature would suggest the latter possibility, and it is hoped, by arousing the personal interest of veterinarians interested in meat inspection, to keep a watch for the typical lung lesions. If the disease still exists in the country it would, doubtless, be encountered during the ordinary routine of meat inspection.

Discussion.—Dr. TOM HARE said that in his opinion the pathology of the Icelandic sheep disease, as described and illustrated by the photomicrographs, was that of a chronic bronchopneumonia with a degree of collapse and compensatory vesicular emphysema, the process in the earlier sites of bronchopneumonia being a nodular metaplasia of the bronchiolar and alveolar epithelium (the so-called adenomatosis). This healing stage or metaplasia in the sheep's lungs bore a close resemblance to the process in chronic tracheobronchitis of dogs (*vide* Hare, T., *Proc. Roy. Soc. Med*, 1929-30, **23**, 1715; *Vet. Rec.*, 1931, **11**, 1074). Tracheobronchitis was due to infection by *Oslerus osleri* (Cobbold, 1879), the mature forms of which invaded the mucous glands and mucosa of the trachea, bronchi, and bronchioles, producing sessile or polypoid cystic granulomata or " worm-nests ". After being vacated by the nematodes, the " worm-nests " began to heal; the resulting nodules of metaplasia bearing a close resemblance to the " papillary intracystic adenomata " shown by Dr. Dungal and Mr. Taylor.

He had not been impressed by the reasons advanced by the authors for excluding nematodes as the cause of the sheep disease. Again turning to tracheobronchitis, clinical cases at autopsy (destroyed on humanitarian grounds) revealed one of three types of lesions: (1) the " parasitic phase ", in which the majority if not all of the lesions contained adult *Oslerus osleri*; (2) the " sterile phase " when no Oslerus or their ova were found in the body; and (3) a " midway phase ", in which a few " worm-nests " contained Oslerus, most of the lesions being sterile and passing through metaplasia to complete fibrosis. He had an idea that tracheobronchitis was due to reinfection at intervals owing to the dogs in unhygienic kennels being continually exposed to the worm. He understood Mr. Taylor to rule out ovine " lungworms " because as many were found in the normal portions as were found in the pneumonic portions of a lung. Such a line of reasoning was inapplicable to avian " lungworm " infection (Gapes) by *Syngamus sp.* and *Cyathostoma sp.*, which were capable of residing within one part of the lung without inflicting macroscopic damage, whereas in other parts of the lung or respiratory tubes others of their species were producing injuries obvious to the naked eye.

In his experience of routine autopsies on old or recent cases of " husk " in sheep, particularly those from parts of the wolds of Lincolnshire and Yorkshire, he occasionally

found one or several nodules of metaplasia in lungs which had been or were affected with chronic verminous bronchopneumonia. He had regarded these nodules of metaplasia as produced by an earlier and departed infection of "lungworms", whereas the common type of chronic verminous bronchopneumonia had been due to a more recent and persisting infection of the trichostrongyles. He had not found the lungs with the numerous nodules of metaplasia as recorded by Sir John McFadyean and as found in the Icelandic sheep, possibly because in this country the rotation cropping of sheep and veterinary control of "husk" had been much improved. He suggested that the high incidence of the metaplastic lungs in Icelandic sheep was due to methods of management which exposed the sheep to continuous or almost continuous infection of the "lungworms".

In conclusion he thought that the sheep disease as described by Dungal and Taylor bore no resemblance to neoplasia, or to a known filtrable virus or bacterial process; on the other hand it was highly suggestive of a nematode infection of the lungs. He would therefore encourage Mr. Taylor to persist with his attempts to reproduce the disease by feeding various species of sheep "lungworms", allowing adequate time for the metaplastic process to supervene upon a chronic bronchopneumonia. The work should result in an expansion of our very inadequate existing knowledge of the activities of "lungworms" under the manifold varying circumstances in nature.

Dr. J. R. M. INNES said that the gross metaplastic changes indicated the true nature —i.e. epithelial—of the cells lining the lung alveoli. This had been a subject of controversy for many years. The exact nature of the lung lesions of this sheep disease was difficult to determine, although they might be regarded as reaction of tissue to some low-grade "trauma". There were several well-known analogies in the field of animal pathology. That the parasite in question was not primarily responsible appeared to have been proved by the investigators.

The ability of these cells lining the respiratory alveoli to transform themselves into columnar epithelium was outstanding in the disease described, but the same metaplasia was well known in other conditions. For example, it had been observed in certain tuberculous lesions of the lungs, in silicosis, and in chronic pneumonias of man. He had also seen it occurring in a mild degree in rabbits' lungs after the injection of BCG. It might be recalled that in experimental vitamin A deficiency the bronchiolar epithelium underwent a metaplasia, but in a squamoid direction. The growth potentiality of these cells lining the bronchioles and alveoli was thus considerable.

With regard to the identification of these lung lesions with a true neoplastic process, it should be pointed out that although the greatest sign of malignant new-growth, namely invasion of neighbouring tissue and setting-up of distant metastases, was missing, yet examination of these sections alone, without the aid of other important facts, almost necessitated the diagnosis of a papillary cyst-adenoma. This conclusion had already been reached by some workers, although they were fully aware of a possible specific ætiology.

He had had the privilege of examining sections of lung lesions from the sheep disease in Kenya which was being investigated by Mr. W. Fotheringham of the Veterinary Research Department in that Colony. The lesions appeared to be identical with those described and illustrated in the Icelandic disease, in Jaagsiekte, and in chronic verminous pneumonia of sheep in Great Britain.

Section of Otology

President—F. J. CLEMINSON, M.Chir.

[*February* 4, 1938]

DISCUSSION ON OTITIS EXTERNA

Dr. H. MacCormac: Otitis externa implies an eczematous or infective condition of the external auditory canal, but in dermatological practice it is rare to meet with an eruption thus confined, and I shall therefore extend the meaning to include the more widely spread eruptions of the ear and behind the ear, first because of their frequent association with true otitis externa, and secondly because they bear directly upon ætiology and treatment.

I shall confine my observations to the two more commen processes, impetigo and eczema. Impetigo is the result of streptococcal—or, in the view of some authorities, staphylococcal—infection of the skin, a delicate blister forming, which on rupturing leaves a superficial raw surface, with subsequent crust or scab formation, this crust presenting a remarkably superficial aspect as if stuck on to the skin. In a fully-developed eruption a mixture of blisters, raw surfaces, and crusts is often seen, representing different types of lesions in different stages of development. The eruption frequently spreads from the face to the ear. Another variety, with which members of the Section are more specially concerned, is secondary to the purulent discharge from middle-ear disease, in which the eruption, originally on the ear, may subsequently spread widely, to involve the face, hands, and arms—that is any part of the exposed skin.

The lesions respond rapidly to 1% ammoniated mercury ointment, to ultra-violet light, or to an ointment containing prontosil. Here we have a straightforward problem, the accidental infection of previously healthy skin by an ascertained micro-organism ; all we have to do is to apply a parasiticide in a concentration sufficient to kill the parasite, but not so strong as to irritate the skin, and rapid and complete cure is the result. Upon these features of impetigo, and its response to suitable treatment, I desire to lay particular stress, because it is often insisted upon by otologists and dermatologists that in the second category, the more chronic eczematous processes—or, as I shall propose to call them, the varieties of seborrhœic dermatitis involving the ear—the most important ætiological factor is an invading micro-organism including such diverse parasites as the streptococcus, *B. pyocyaneus*, the pityrosporon, or other monilias. This finds strong support in the opinion of an eminent French dermatologist, Dr. R. Sabouraud, who describes the retro-auricular intertrigo as the epidermic streptococcal lesion in its most frequent localization.[1]

This view, I suggest, is not confirmed by the therapeutic test, for if the various organisms, the cocci, bacteria, and pseudo-yeasts, were the primary and essential cause of the eczematoid eruptions, the response to suitable antiseptics should be rapid and complete, which is contrary to clinical experience. Further, so far as the yeast-like organisms are concerned, it has been shown by Dr. Allan Bigham [2] that they are present in normal skins more frequently than in the abnormal. They are thus, it would seem, secondary or contributory factors living in an already diseased tissue, differing fundamentally from the relationship of the streptococcus to impetigo.

If we reject the theory of an infective origin and take another view, classifying these conditions as manifestations of seborrhœic dermatitis, it may be asked what

[1] "Entretiens dermatologiques", Paris, 1912, p. 295.
[2] *Brit. J. Dermat.*, 1937, **49**, 74-79.

evidence is forthcoming to support this hypothesis. The definition of what we mean by seborrhœic dermatitis is far from easy, for it is a protean dermatosis whose characteristics clinicians have had much difficulty in determining.

I will, however, suggest that the key-type is represented by an eruption which affects the scalp, presternal, and interscapular regions, where it may persist in a relatively inactive phase causing little or no inconvenience. Not infrequently other areas are simultaneously or subsequently involved, especially the flexures behind the ears, the axillæ, groins, and intergluteal cleft. A further stage is characterized by eczematization, when the eruption assumes the qualities of an eczema, sometimes including the face, which then becomes swollen and œdematous. Having for the purposes of the argument rejected the theory of infection, it is necessary to seek elsewhere for some common factor, and I suggest that a perversion of the functions of the glands in the skin may satisfy these requirements. The evidence is inferential rather than direct. Thus the key-type of seborrhœa affects the scalp, presternal, and interscapular regions, where the sebaceous glands are most densely distributed. Further, the ringworm infections of the head die out spontaneously at, or shortly after, the establishment of puberty. This is most reasonably explained on the assumption of a physiological alteration in the secretion of the sebaceous glands attached to the hairs, which inhibits the growth of the ringworm fungus, and, as it may be speculated, by reason of some disturbance of functions, later on invites the seborrhœic eruptions. Some confirmation of this theory is found in the remarkable fidelity of seborrhœic eczema, to the hair-bearing regions—the scalp, beard, and eyebrows ; and in the presence of the tiny red follicular spots, which are observed in presternal seborrhœa as the originating lesion of the more extensive sheets and patches of eruption. Nothing so far has been said on the nature of the eczematous reaction which is so often superimposed on the seborrhœic process. In his masterly analysis of seborrhœa Civatte [3] has emphasized the importance of an intercellular œdema which, as the microscope reveals, dissociates the cells of the rete malpighii. This intercellular œdema is a characteristic and essential phenomenon in all forms of eczema, and by its further development in seborrhœa the typical eczema reaction is established. Thus the seborrhœides are predisposed, by reason of their structure, to eczematization. This theory, with all its manifest defects, is at least useful as a working basis for treatment. It envisages three separate factors : (1) An essential dermatitis, possibly of glandular origin ; (2) a contributory infection with a group of organisms varying from streptococci up to the monilias ; and (3) an actual or threatened eczematization. In each individual case the degree and importance of these several factors demand separate consideration.

The skin is often spoken of as a gas-tight and water-tight envelope which covers the body, protecting it and preventing desiccation from evaporation of the body fluids. It is, of course, far more than this, for it is one of the largest organs of the body, charged with many and important functions. It is logical therefore in the treatment of skin diseases to endeavour to heal the eruption by external agents, both chemical and physical, which act directly upon the lesions, and this, with certain notable exceptions, forms the basis of dermatological therapeutics. For practical purposes these remedies may be divided into three classes : First the simple protective and soothing ; secondly the selective, which may be so called because of their specific effect on certain diseases ; and thirdly the parasiticide, including antiseptics.

In the treatment of otitis externa the soothing or protective agents are indicated where eczematization is present either in a pronounced or moderate degree, as in most forms of eruption of the meatus. Oily calamine lotion is the most generally useful : it can be applied either directly, or on cotton-wool saturated with the solution. The residual powder is cleaned off with liquid paraffin—and this applies especially to the meatus. A simple remedy of this kind may appear inadequate where bacterial

[3] *Brit. J. Dermat.*, 1924, **36**, 471.

contamination is detected, seemingly demanding the use of antiseptics or similar active agents. In this connexion two cases may be quoted. The first refers to a medical practitioner who developed a boil in the external auditory meatus, complicated by cellulitis with high fever. This was followed by a chronic discharge from the ear contaminated by *B. pyocyaneus*. In spite of the application of various antiseptics and vaccine treatment the discharge and local irritation persisted for four months, when the antiseptics were discontinued and calamine liniment with ichthyol prescribed. In two days the condition was cured. The second case refers to a patient, C. A. C., who stated that his ear-drums had been ruptured during the War. He was seen in 1932 with a discharge and eczema of the right auditory meatus following his War injury. During the whole period since the injury he had faithfully applied various drops and antiseptics without effect. Calamine liniment with ichthyol was ordered, and within a few days the condition was completely cured and has remained so ever since.

These two patients are without parallel in my practice, for the average case of otitis externa is far from being so responsive. They taught me the significance of over-treatment, a lesson I have since endeavoured to keep in mind when treating similar conditions.

The selective agents include tar and sulphur. In retro-auricular dermatitis crude coal-tar is often an effective remedy. It is prescribed in zinc paste, a drachm to the ounce; or perhaps more conveniently dissolved in acetone and used as a paint. In the latter form it may be applied to the folds of and behind the ear. Its disadvantage lies in the dirty appearance that it produces. In general terms it can be said that where tar is indicated, X-rays are useful. X-rays are not used alone; they are complementary to the local applications and probably act in two ways—by diminishing the itching and acting on the glands in the skin. Their effect in modifying itching is important, because many eczematous conditions of the ear are maintained by the constant rubbing and scratching of the affected skin. Relatively small doses are sufficient, and can be repeated at two to three weeks' intervals. Sulphur has been mentioned, but it is perhaps best avoided because, although useful in some cases, it tends in others to precipitate the eczematous response, thus aggravating the disease.

Finally a word may be said on the use of antiseptics. The association of the streptococcus with retro-auricular dermatitis may demand special treatment, but it is essential to use the remedy in a form and manner which avoids irritating the underlying dermatitis. Silver nitrate, 1%, dissolved in sweet spirit of nitre seems to meet these requirements; alternatively 1 : 5,000 acriflavine solution may be used, applied on gauze.

Dr. G. Ewart Martin: Otitis externa is purely a skin complaint which, but for the curiosity of its position, would come under the care of the dermatologist: when the auricle is involved the dermatologist is consulted, and when the meatus is infected the otologist has to diagnose and treat.

Every skin infection has two causal factors: (1) The invading organism. (2) The receptivity of the individual.

(1) In the production of an otitis externa, apart from a blood-borne infection, there must be an initial lesion of the skin surface to allow of the entry of the organism. This can be brought about by direct injury on the part of the patient himself by scratching the ear, or by the use of a hairpin or a match-stick to remove wax. Injudicious drying, or rubbing, of the ear may be the cause of the initial injury. Syringing the ear with either too hot or too irritating a lotion, or damage by the point of the ear syringe, may be the primary factor in the production of an otitis externa.

(2) The second factor is possibly the patient's physical condition, though dermatologists are convinced that certain individuals are more prone to skin affections than others, while heredity, climate, and habit all play their separate parts.

No benefit will be obtained by discussing at length the various types of otitis externa, as, for example—

(i) The acute circumscribed external otitis or furunculosis of the meatus which is almost always confined to the fibro-cartilaginous portion of the meatus.

(ii) The diffuse otitis externa, which may be either acute or subacute with the invading organism, usually streptococcus, very often going on to an erysipelas of the auricle and where the whole canal is involved.

(iii) Croupous and hæmorrhagic external otitis which, fortunately, are rare, though cases of the former very often occupy the beds in a fever hospital for weeks.

(iv) The various infections due to fungi usually grouped under the title otomycosis. These infections are possibly mixed, there being first a mild staphylococcal infection followed by the invasion of a fungus—the infection may be confined to the walls of the bony meatus, but it may spread over the drumhead. Possibly *Aspergillus niger* is the most common infective fungus and the most often missed.

Eczematous otitis externa, hower, demands fuller discussion. It may be acute or chronic.

The acute stage is possibly of short duration ; there may be a tense glossy redness of the lining of the external auditory meatus with a varied amount of oozing, sometimes hæmorrhagic. Each case probably goes through all the phases of the eczema reaction and may be seen in any one of the stages, thus accounting for the various descriptive findings. Itching is not usually continuous but recurs every few hours and is exaggerated when the patient is at rest or over-heated. Scratching tends to aggravate the condition. The inflammation usually flares up and dies down several times before healing takes place. In most cases the initial stage is rarely seen as the patient only seeks advice when the condition has become chronic. The condition may last for one week, months, or even for years, but in most cases eventually heals without scarring. The organisms found are the usual simple organisms found on the skin, namely the staphylococcus, diphtheroids, a Gram-negative coccobacillus, and a streptococcus.

In chronic cases the appearance of the meatus varies from that of a scaly dermatitis to a marked lichenification leading to a stenosis of the meatus, and almost amounting to a condition of elephantiasis.

Two factors are necessary for the development of the eczema reaction : (*a*) A specific irritant, and (*b*) a skin which is idiosyncratic with regard to the irritant in question. The term " irritant " is a relative one, for in almost all cases the irritant in a given case is not a universal irritant ; its irritant properties being dependent on the degree of skin idiosyncrasy. Such irritants may be physical, chemical, or bacterial—using the last term in its widest sense—and while they usually come in contact with the skin from outside, they may reach it by way of the blood-stream.

With bacterial irritation preliminary chemical injury or mechanical trauma is an important adjuvant in initiating the eczema process. The skin idiosyncrasy or hypersusceptibility to the " irritant " is usually strictly limited to one substance or possibly to a few substances. It may be congenital or acquired and, while usually shown by the entire skin surface, it may be limited to a localized area. The development of idiosyncrasy has been shown to be due to previous contact with the irritant, but this has been demonstrated only in a few cases. In the majority of cases no reason is evident for the change in the skin response. The essential feature of the eczema reaction, when contrasted with the recognized reaction to injury, is its persistence for long periods, in other words the lack of any immediate tendency to progress towards healing.

Eczema of the external auditory meatus, in its acute and chronic stages is not accompanied by deafness unless the meatus is blocked. There is no pain unless the ear has been scratched or secondarily infected, but there is an intolerable itch, with a constant feeling of fullness, and a wet, sticky, uncomfortable ear or—when the

eczema is chronic—a dry scurfy irritable meatus with a thickening passing on to the auricle.

If we are right about our supposition of the causal factor of the various groups of otitis externa, then acute otitis externa or furunculosis possibly follows the same seasonal periodicity as an acute otitis media, while eczema of the external meatus should be endemic.

I have reviewed all the cases in my own department of the Royal Infirmary, Edinburgh, during the last four years, and also the cases seen in private practice during the same time. It might have been more beneficial to have taken the cases over a longer period, but during this time we have tried to separate the two groups of cases as much as possible.

TABLE I.—CASES OF OTITIS EXTERNA UNDER MY CARE IN THE EAR, NOSE AND THROAT DEPARTMENT OF THE ROYAL INFIRMARY EDINBURGH.

1934	268
1935	206
1936	207
1937	271
Cases of Acute Otitis Externa or Furunculosis:—	
1934	119 (46%)
1935	112 (54%)
1936	107 (51%)
1937	152 (56%)
Cases of Eczema of the Meatus were:—	
1934	95 (35%)
1935	62 (30%)
1936	69 (33%)
1937	81 (29%)

TABLE II.—FOR COMPARISON WITH TABLE I. CASES OF ACUTE OTITIS MEDIA, CHRONIC OTITIS MEDIA AND OTITIS EXTERNA REPORTING FOR THE FIRST TIME DURING THE SAME PERIOD.

	Acute otitis media	Chronic otitis media	Otitis externa
1934 ...	214	217	268
1935 ...	247	229	296
1936 ...	205	255	207
1937 ...	216	270	271

TABLE III.—CASES OF OTITIS EXTERNA.

Furunculosis		Dermatitis of the auricle	
Private cases	R.I.E. cases	Private cases	R.I.E. cases
31%	51%	58%	32%

There was one private case of *Aspergillus niger*.

TABLE IV.

Monthly Total No. of Cases	1934				1935				1936				1937				Average for four years			
	Otitis Ext.	Eczema	Furuncles	Acute O. M.	Otitis Ext.	Eczema	Furuncles	Acute O. M.	Otitis Ext.	Eczema	Furuncles	Acute O. M.	Otitis Ext.	Eczema	Furuncles	Acute O. M.	Otitis Ext.	Eczema of Meatus	Furuncles	Acute O. M.
Jan. ...	21	7	8	46	24	6	14	33	12	4	6	21	15	3	8	29	18	5	9	32·25
Feb. ...	25	11	9	36	16	6	8	35	23	8	12	26	18	3	14	10	20·5	7	10·75	26·75
March ...	19	7	9	27	18	4	10	24	23	8	12	24	16	4	12	21	19	5·75	10·75	24
April ...	23	8	11	15	13	2	6	23	18	4	8	18	10	—	10	22	16	3·5	8·75	19·5
May ...	22	9	7	18	15	4	8	17	14	2	11	17	17	7	8	19	17	5·5	8·75	17·75
June ...	19	8	10	10	8	1	6	17	22	7	12	22	26	10	12	16	18·75	6·5	10	16·5
July ...	26	7	17	12	24	4	17	17	12	6	2	11	25	10	12	14	21·75	6·75	12	13·5
Aug. ...	28	10	13	19	18	11	8	15	16	6	7	14	28	9	10	13	22·5	9	9·5	15·25
Sept. ...	21	13	9	10	19	5	12	12	8	3	5	13	27	11	12	11	18·75	8	9·5	11·5
Oct. ...	26	9	9	15	11	3	6	17	25	6	16	12	29	10	15	15	22·75	7	11·5	14·75
Nov. ...	19	2	11	17	22	8	10	16	17	10	6	14	25	7	15	16	20·75	6·7	58	15·75
Dec. ...	19	4	6	18	18	8	7	21	17	5	10	13	35	7	24	28	22·25	6	11·76	20
Total ...	268	95	119	243	206	62	112	247	207	69	107	205	271	81	152	214				

TABLE V.

		In the Royal Infirmary			In private	
	Total	Male	Female	Male	Female
Furunculosis ...	490	265 (54%)	225 (46%)	52%	48%
Eczema	307	172 (56%)	135 (44%)	54%	46%

The *ages* of cases vary from 2½ years to 76 years, the general age being 36.
The *organisms* vary (staphylococcus, diphtheroids, Gram-negative coccobacillus and streptococcus).

There is, of course, in these statistics, a large source of error, because the otologist sees only a very small proportion of the cases of external otitis, except in acute furunculosis when pain drives the patient to the specialist. In these cases the condition is quiescent for a long period and then recurs, very often more aggravated than previously. Among them were doctors, nurses, housewives, school-teachers, clerks, bus-conductors, miners, engine-drivers, shop-assistants, commercial travellers, labourers, chauffeurs, telephone operators, and soldiers, therefore a sedentary life or an active life can have little to do with the occurrence. Occupation plays little or no part. The usual age is from 30 to 36.

Furunculosis increased during the beginning of the swimming season, that is in July, otherwise it followed the same seasonal course as acute otitis media. Eczema of the meatus showed itself more active in August, probably again due to the increased use of swimming baths and sea bathing. There was no proof that general debility had much bearing on furunculosis.

The period of treatment varied from seven days to two years.

TREATMENT

(1) *The cleansing of the external auditory meatus.*—Syringing with warm boric lotion is the best means of removing epithelial debris, or watery—and very often bad-smelling—discharge from the meatus. Strong antiseptics increase irritation. Weak lysol or carbolic lotion may harm many who have an idiosyncrasy to it. In a few cases it may be necessary to cocainize the meatus before removing the crusts, especially when the meatus is narrow and the auricle thickened. Hydrogen peroxide, if used to moisten the crusts in an otitis externa, only seems to irritate, and very often leads to eczema of the meatus. It should never be left in the ear.

(2) *The application of a suitable non-irritating antiseptic or other local treatment.*—The treatment of acute and chronic cases must naturally differ.

Acute otitis externa or furunculosis.—In the Royal Infirmary, Edinburgh, it has been our practice in furunculosis not to incise, unless in extreme cases, believing that incision will only act as a further point of access for the invading organism. After the meatus has been cleansed and the extent of the furunculosis defined, the meatus is packed with 7½% solution of aluminium acetate in water. This acts as a dehydrant and also has a slight anæsthetic action. The use of a compress of a solution of magnesium sulphate over the ear, in conjunction with the aluminium acetate packs, gives comparative relief from pain. The pack is removed after twenty-four hours, when it is found that the furuncle or furuncles have burst. Aluminium acetate gives rise to desquamation in the ear. It has been found best not to syringe out the ear after the first or second aluminium acetate pack, but to reinsert the pack without syringing until the third day. The pack is changed to 10% ichthyol in glycerine on the third day. Usually at the end of the third or fourth day the meatus is normal. As furuncles come in crops treatment must be continued until the meatus is healthy. It has been found beneficial to paint the ear with 2% gentian violet in water.

Treatment by packs of a suitable antivirus, either in liquid form or in a paraffin or vaseline basis, has proved effective, but not in the later stages.

Ointments tend to clog up the ear, demand more cleansing, and often give rise to a superficial thickening of the drum. When the auricle is affected the

necessary antiseptics can best be applied as an ointment, such as ichthyol in a diluted paste base, or 2% sulphur and salicylic acid in vaseline, or ammoniated mercury ointment.

Eczema of the meatus.—In the early stage, gentle syringing with boric lotion will clean the meatus, but great care must be taken not to damage the deeper parts of the skin for fear of a secondary streptococcal infection. The ear can then be packed with aluminium acetate for twenty-four hours, and later with 10% ichthyol in glycerine. In the chronic stage the ear has to be cocainized before the scales can be removed by syringing, and it is then painted with 2% silver nitrate in spirit of nitrous ether. If the case is first seen when the meatus is narrow and the auricle glazed, enlarged, and thickened, an attempt must be made to dilate the meatus by packing with ichthyol or argyrol in glycerine until there is room for removal of the scales.

No case can be counted as cured unless the ear has remained dry, unitching, and non-scaly for two years.

(3) *Treatment of the cause.*—General treatment has been addressed to constitutional disturbances, idiosyncrasies, and any neuropathic upset. In acute furunculosis which has become chronic, vaccine therapy, and injections of various remedies—such as manganese—have proved effective. In eczema of the external meatus the administration of vitamins A and D seems to be the only general remedy.

Mr. Eric Watson-Williams said that otitis externa almost disappeared from the realm of difficulty if hydrogen peroxide were rigidly excluded from the ear and indeed from the otological department altogether.

The skin of the ear was not quite the same as the skin of the rest of the body. It was provided with cerumen to keep it waterproof. Therefore, except when syringing for foreign bodies, water should on no account go into the ear.

For local application to the very resistant case with infiltration, he used Bonney's paint (1% of brilliant green and of crystal violet in 50% alcohol). It stained the patient's bed-linen, and it was essential to cover the ear.

In most cases of otitis externa, local treatment was not more important than general.

In impetigo if it were made a rule to give the children iron for a month the result was to shorten and simplify the treatment of the ear very greatly.

Another troublesome condition not often seen now was a gouty otitis externa: local treatment was not indicated, but if the gout was brought under control, the ear trouble would cease. Manganese was a modern fashionable remedy. Mist. ferri arsenicalis gave quite as good results.

Mr. Ritchie Rodger said that in the chronic eczematous processes involving the ear, the dangers were the use of too strong preparations and the scratching of the irritating itching ears. If those two things could be eliminated most cases would clear up very quickly. He had found little difficulty in getting the cases under control with a simple ointment of zinc oxide and salicylic acid, 5 gr. of each, in lanoline, which seemed better than vaseline for the purpose.

With regard to furunculosis, he agreed that they must go beyond the local application. Many patients had had boils elsewhere, indicating a diminished resistance to the staphylococcus. He had generally used collosol manganese, with iron and arsenic given internally as well.

Mr. W. S. Thacker Neville said that in seborrhœic eczema silver nitrate followed by ultra-violet light was worth employing. The best treatment for furunculosis was diathermy. Both ears were treated with diathermy to prevent the vertigo, which

would occur if one ear was treated. After such treatment the furuncle became swollen and soft and, on the night after the treatment, this resulted in pain which might necessitate the use of morphia unless the furuncle was opened. The drawback to diathermy was that it necessitated the use of lint soaked in saline and also the employment of pressure. He had lately employed a Siemens short-wave 6-metre machine and with this it was possible to focus the heat and there was no need to apply pressure, as the glass covering the electrodes merely touched the ear. Such heat was the perfect heat for a furuncle, and it was possible to use it no matter how tender the ear was.

Mr. J. F. O'Malley said that he had always found cases of seborrhœic eczema associated with seborrhœa of the scalp, and any attempt to treat the local ear trouble would be futile unless the scalp were treated simultaneously. To treat the scalp satisfactorily an effective shampoo had to be used. In the early stage when the ear trouble was fairly active the shampoo should be used twice a week for five or six weeks. The most effective shampoo was soft soap dissolved in spirit.

There were two phases of the local ear condition which were always obvious, namely, active weeping raw spots, and, simultaneously, patches undergoing scaly change. The treatment he had adopted was calamine lotion and afterwards a combination of Lassar's paste, ammoniated mercury ointment, and liquor carbonis detergens, making a thin ointment with liquid paraffin. If the scaly trouble was persistent he added salicylic acid.

Mr. T. B. Layton said that he had only seen acute hæmorrhagic otitis externa in influenza, but he believed that it was always secondary to an inflammation of the middle ear passing up from the nasopharynx. If one thought of the condition purely as an otitis externa, one might not realize that it was possible for the trouble to pass backwards into the mastoid, antrum, and even to the bone.

With regard to Mr. Martin's group of croupous otitis externa, he had only once seen a case of diphtheria of the outer ear ; a membrane spread out to the pinna. He believed that in all the other cases it was a question of a potentially virulent bacillus growing as a saprophyte. In a moist external auditory meatus the moisture was usually the result of discharge from the middle ear. Very often in these cases it was not a question of the virulent Klebs-Löffler bacillus, and he did not think that the patients should be sent to a fever hospital until a virulence test had been carried out. In the out-patients' department a small amount of education of the mother should make it perfectly safe to prevent the spread of infection. If the organisms were in the nose as well it was, of course, a different problem.

He thought this form of croupous otitis externa differed very little from the otitis externa which was secondary to otitis media. It was important to remember that all these skin organisms needed moisture in which to grow. If the ear was kept dry their growth was inhibited, but a liquid was required to keep it dry, and for this purpose he found glycerine the most useful. At the same time, in cases of otitis externa secondary to otitis media there was a considerable amount of epithelial debris, and sometimes this was very difficult to mop off the surface of the drum-head ; moreover, by mopping, the organism might be driven through the perforation and give rise to secondary infection of the middle-ear cleft. The mechanical technique required to remove this debris in such a way as not to do more harm than good was a very delicate procedure. Hydrogen peroxide he thought of value but great care must be taken to remove all of it afterwards and then to dry the ear. He agreed with Mr. Thacker Neville that in cases of furunculosis the mental factor was important. He believed it to be the most important of all.

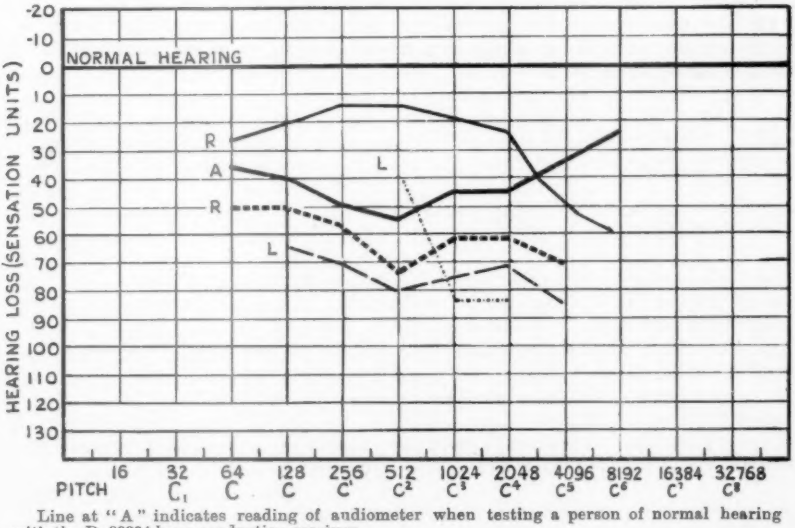
Mr. Horace Mather agreed that the wholesale use of peroxide was a most disadvantageous thing, but the real trouble was the fact that peroxide contained sulphuric acid, which is put in commercially, to prevent the peroxide returning to water. It was the sulphuric acid which was the mischievous element, and if only the sulphuric acid was diluted immediately before use with bicarbonate of soda, the peroxide could be used with perfect safety without any trouble to the skin of the meatus.

Mr. A. Tumarkin said it seemed to be taken for granted that if an ear was syringed it was thereby cleaned completely, whereas in fact, the inferior margin of the tympanic membrane formed an acute angle with neighbouring structures and the lack of thorough cleansing in this region might lead to re-infection of the tissues. For clearance by syringing he used 70% spirit. If one wanted to dry the ear ether was by far the best thing to use. He was glad that one of the speakers had mentioned the great importance of the scalp in seborrhœa.

The following case was shown :—

Chronic Labyrinthitis.—E. A. PETERS.

(This case was reported in *Journal of Laryngology, Rhinology and Otology*, 1913, p. 101.) G. H. (now aged 84). In 1912 chronic labyrinthitis with vertigo. Drainage of perilymph of left external semicircular canal by insertion of one end of a strand of silkworm gut into the left external canal and the other between the bone and



Line at "A" indicates reading of audiometer when testing a person of normal hearing with the D–80904 bone conduction receiver.

Continuous line indicates perception via membrana tympani; Interrupted line, perception *via* bone conduction.

dura mater. Recovery from vertigo. Perilymph has been seeping through the wound until three months ago. Vertigo has now reappeared.

Condition on admission (May 2, 1912).—There has been gradual loss of hearing, and for the last two years vertigo has been present and has increased; patient has

a tendency to fall backwards ; sometimes he has been unable to cross the room unaided. Hearing : 12/60 ; T.F. 128 — 9 secs. Labyrinths show diminished sensitivity to rotation ; nystagmus is slight and erratic.

At the operation the antrum was opened by a post-aural incision and the posterior approach made to the external canal was uncapped and a silkworm gut strand passed into the canal and the other end passed into the posterior fossa extradurally. A skin-graft was applied. Slow but uneventful healing took place with continuous seepage of perilymph. September 1912—Hearing : 14/60 ; T.F. 128 — 7 secs.

Present condition.—The patient complains that since the ear became dry the vertigo has reappeared, but the type is not so severe as before and there is no definite direction. He can walk a mile. Left ear : Antral cavity dry. The tympanic membrane is seen with injected malleus and is thickened ; it is mobile. The audiometric graph shows considerable loss of conduction in the left ear and a labyrinth about 15 decibels inferior to the right. This evidence indicates that there has been a chronic labyrinthitis on both sides, with greater involvement of the left. Drainage of the left external canal was effective in the first instance, but now the seepage has ceased and vertigo has reappeared in a modified degree.

Rotation test : Nystagmus cannot be detected on extensive testing, nor does the patient feel giddy on completion of rotation.

I submit that the case shows :—

(1) That drainage of the perilymph has relieved the vertigo without destroying the hearing.

(2) It is doubtful whether this relief is due to drainage of a labyrinthitis or of a condition arising from insufficient drainage which in the ear resembles glaucoma in the eye.

(3) The cessation of seepage into the outer ear accompanied by a relapse of vertigo suggests that the drainage into the extradural space was insufficient. This attack of vertigo was not severe.

Section of Psychiatry

President—E. GOODALL, C.B.E., M.D.

[*December* 14, 1937]

Psychoses in Children

By MILDRED CREAK, M.D.

THE problem of the psychotic child is one which, if not insoluble, is at any rate not solved. This study is presented, therefore, for discussion, rather than as new material from which conclusions may be drawn, and no attempt has been made as yet to enlarge the inquiry to one of statistical value.

Not the least of the difficulties has been to trace and then to evaluate the present condition of the cases referred to. The clinical material is supplied by the discharges from the Maudsley Hospital Children's Department, both in- and out-patients, during the years 1935–36 and 1937 to the end of September. The children are boys and girls below the age of 16, and the cases include all those who were given, on discharge, a diagnosis of a psychosis.

With one exception, to which attention will be drawn later, the organic psychoses —i.e. psychosis with known cerebral lesions such as congenital G.P.I.—are not here considered. Nor are those cases with epilepsy, encephalitis and chorea included, since a major part of the responsible pathological process is known.

Limiting the inquiry in this way, there are 35 discharged cases under review, with one special case—an organic deterioration referred to in the text—added for comparison. Any doubtful cases are excluded—one, for instance, in which an attack of mental dullness, anxiety, and a state of fatigue and apathy was associated with some evidence of an intercurrent physical illness, possibly a septic focus, which resulted in a retrobulbar neuritis from which there was complete recovery. While a schizophrenic illness was properly queried, it seemed that other explanations were possible.

On the other hand, cases of borderline mental defect, in which the psychosis has clearly supervened, are included, and form one of the more clearly differentiated groups.

It was not realized until after a preliminary survey that this study could be regarded as one of schizophrenia. The affective psychoses in children are known to be rare—a point made by Kasanin (1931), and Kanner (1935) speaks of them as exceedingly rare. Since the total number of discharges from the Children's Department during the period under review was 1,265 cases, it is surprising, but corroborative of these views, that the series included no instance in which a certain diagnosis of affective psychosis could be made. It will be seen that a few cases show a marked mood-swing and that in one, this was so pronounced—wholly constituting the disease and dominating the clinical picture for months—that a tentative diagnosis of manic-depressive psychosis was made.

In this connection it is interesting to compare this series with the observations of Kasanin and Kaufmann (1929–30) working at the Boston Psychopathic Hospital, and those of Burger-Prinz (1935) working in Leipzig. Kasanin and Kaufmann took for study 25 cases of functional psychosis from a total of 160 psychotic children. Of these 21 were accepted as cases of schizophrenia, and four were diagnosed as cases of manic-depressive psychosis. But in two of the four, the diagnosis was at least doubtful, both showing schizoid features and one being almost certainly hallucinated. It is therefore possible that subsequent observations will not justify placing these

two cases in the affective group, bringing the numbers down to two certain cases, both over 14 years, among 160 psychotic juveniles. This is of more than academic importance, since it cannot be denied that many cases present themselves with a clinical picture of marked affective disorder and mood-swing. Great caution should be observed in making an early diagnosis of manic-depressive illness, with a good prognosis, apart from the fear of recurrences. Many such cases, in the long run, prove to be early schizophrenic reactions, and the presence of an affective colouring cannot, in our present state of knowledge, be taken as even suggesting that the disease may be of the benign type, with complete or lasting remissions.

Burger-Prinz, referring to the work at the Kinderpoliklinik in Leipzig, considers the material for the last nine years, finding 68 cases which were certainly psychotic. Of this group of 68, he regards 20 as true schizophrenics, 20 as manic-depressives, 20 as cases of psychoses or psychotic episodes in unstable, psychopathic juveniles including some temporary derangements at puberty, and eight cases in which he is not prepared to make a differential diagnosis between schizophrenia and manic-depressive psychosis. The striking thing about his observation is, of course, the remarkably high proportion of affective psychosis. This can be understood when he describes his diagnostic criteria. Among depressive cases, he includes many who showed catatonic phases, stereotypy, and periods of stupor and incontinence. He admits also cases with anxiety of an aimless detached kind, and some expressing hypochondriacal ideas. Many of these would, according to our standards, be regarded as examples of acute schizophrenic illness, and a complete recovery or, what is more likely, remission, is not taken as in any way vetoing the diagnosis of schizophrenia.

This leads to the very difficult question as to what exactly constitutes a schizophrenic illness in a child. Probably Macfie Campbell's (1935) definition of schizophrenia is as wide as any in current use, and is the standard adopted in the survey already referred to of Kasanin and Kaufmann :—

> "The schizophrenic type of reaction seems to be characterized by diminished interest in, and adaptation to, the workaday world, increased interest in subjective creations, or fantasies which are emancipated from the control of ordinary, logical and scientific thought; the frequent occurrence of hallucinations, odd and fragmentary behaviour and utterances of little adaptive value in relation to the present situation."

To this might be added, in particular, the tendency to fragmentation and interruption in the thinking processes, dereistic thinking, which presumably lies behind the odd utterances and behaviour, the tendency to stereotypy of thought, action, and expression, the poverty of output compared with capacity, the emotional lability with inappropriate responses and poverty of affect, apathy and negativism, and tendency to regression to simpler, more archaic levels, and not least the disordered metabolism.

Our clinical conception of schizophrenia in its developed state is built up mainly from the observation of adults, many of whom have already regressed considerably. How far is the picture modified when it is considered in relation to the child, whose intellectual, physical, and emotional growth is still proceeding, so that a regression to an infantile level is by no means a rare occurrence, or necessarily one of sinister import ?

Piaget (1929), in the " Child's Conception of the World ", has demonstrated the extent to which the normal thought processes, at an early age, recapitulate those primitive and archaic forms so often seen in schizophrenics. The drawings of children will often show such features. Even on the perceptual plane the child may experience a form of fragmentation highly reminiscent of the adult schizophrenic. A rather backward 4-year-old recently came into my clinic and looked out of the centre one of three similar windows. He saw a cat on the lawn, and called out, " A pussy ! ". He then ran to the second window, looked out again, saw the same cat from a slightly different angle, and said, " Another pussy ! ". He then started off for the third

window, paused, contemplated, and changed the subject quite abruptly. My impression was that at that moment there dawned on him some realization of the fact that his sensory experiences concerned the same object. But the effect, on the observer, both of the original separateness of the two experiences, and the repetitive behaviour, was of a great similarity to some examples of clearly schizophrenic behaviour. Here it was entirely due to a physiological immaturity.

All normal children live in their fantasies to a greater or lesser degree; they vividly hallucinate imaginary companions and terrifying and menacing objects in the dark. Most children have their stereotypies, their pet phrases, their rituals, their repeated forms of play. The delight in a story or nursery rhyme often seems centred in the senseless repetition of some neologism, and who has not seen a child excited to the point of instability with little apparent cause, or rendered pallid and apparently apathetic with anxiety? Negativism is a normal characteristic of the pre-school phase, and mutism not uncommonly occurs—as, for instance, in a child aged 3 seen recently, who following a return home after a short period of necessary hospitalization, was mute for three days. The regression, even of older children, in times of emotional disturbance, to infantile traits of enuresis, or fæcal incontinence, is no rare occurrence, and very probably is of little significance except as an indication of such disturbance. The path of maturation is a long one, and at any stage a regression of a purely temporary kind may occur. What is the characteristic which distinguishes such behaviour from similar examples which are at once seen as significant stages in the evolution of a serious psychosis? Is it the age at which such events occur (I have seen fæcal incontinence in an intelligent boy of 12, associated with theft from an unsympathetic stepmother), their temporary nature, their understandability (although the patients rarely understand their mechanism), or is it that they are merely seen as episodes in a life-history, which in other respects appears to be pursuing a normal course?

Wildermuth (1923), quoting Bleuler, compares and likens the schizophrenic and the child at play. Mayer-Gross (1921) has said :—

> "The bearing of the schizophrenic is remarkably like that of someone at play. He enters into a special world, with its own laws, which are, however, not without some relation to reality. Nevertheless, at any moment reality may burst in and interrupt this process. Seen from outside this 'double life'—of the world of reality on the one hand, and the fantastic world on the other—closely resembles the behaviour of the playing child, who holds his fantasy carefully separated from the incursion of reality. He will regard as a spoil-sport anyone who tries to confuse the two kingdoms."

Bearing in mind, then, the frequency with which symptoms can be observed in children destined for normal development, which in others may persist, intensify, and herald a progressive deterioration, can any group be singled out in which the distinction is never for long in doubt?

Kraepelin (1913) noted and described a small group of cases in young children, in which during the first decade of life, a progressive dementia sets in, with features indistinguishable from those marking the schizophrenic dementias of older patients. He regarded it as a variety of schizophrenia, as indeed the essential schizophrenic deterioration setting in before the environmental factors would be held as contributory. Sante de Sanctis (1906) described as "dementia precocissima" a group of cases in young children, some with recovery but others going on to catatonic states resulting in more or less severe degrees of mental defect. Since the formative years in a child's emotional development are held to be those before 5 years of age, the contention that environmental factors may be disregarded in these early cases can no longer be supported. Nevertheless, some of them arise so dramatically in a situation which seems to bear no relation to the ensuing illness, that one is driven rather to the conviction that further investigation will reveal an organic and demonstrable cause. I refer, of course, to the group, possibly synonymous with Sante de

Sanctis' dementia precocissima, described in 1908 by Theoder Heller (1909), as "dementia infantilis". It is unfortunately impossible to get access in London to Heller's original paper, but the work is referred to more recently by Zappert (1922) who, in collaboration with Heller, discussed some of the early cases, which were then under care in institutions, and added seven of his own. The remarkable feature in Heller's cases, and those of Zappert, is the uniformity of the symptoms. This, to my mind, is unlike most examples of schizophrenic illness, whose descriptions, while including features all bearing a certain sameness of quality, yet cover an enormously wide range of variety in actual manifestations. They are like different pictures by the same master, as varied as their subjects, but all marked with an instantly recognizable quality, rather than different pictures of the same object.

The characteristics of Heller's dementia infantilis are firstly the age of onset. All the cases described were of normal children, with uneventful development in infancy, who at the age of about 3 or 4 years first showed abnormal signs in an alteration of speech. There is a tendency to an abrupt cessation of learning, with lalling, echolalia, and verbigeration. Speech is rapidly (that is within a few months) reduced to the stereotyped repetition of a few sounds. Meanwhile the child's behaviour deteriorates, he becomes restless, and aimlessly overactive, he is destructive, progressively less able to feed himself or to occupy himself in any way except in aimless activity, and he becomes dirty in personal habits; as Zappert—quoting Heller—says, he "becomes an idiot in a few months".

The illness is remarkable in that, while this severe deterioration is in progress, the facial appearance of the child remains bright and alert, and the co-ordination of his movements is unaffected. There are no physical signs of organic disease, the sensorium remains intact and the cases have not been known to follow any physical illness. The prognosis is absolutely bad, and they remain under care in institutions for the mentally defective. Since nothing has appeared regarding this illness in the literature of this country, it can be surmised that some cases find their way into such institutions, without any particular note having been paid to the fact of the normal early development. They are, in any case, rare, but they deserve alignment with the schizophrenic group, since they furnish examples of a dementia in which stereotypy, mutism, and regression to infantile habits are reached, so that the end-points here and in the more usual schizophrenic illnesses are indistinguishable. Zappert inclines to regard them as schizophrenics, but believes that serious brain damage of an unknown kind occurs, and his view is that in time, enough will be known about schizophrenia to find such damage there also.

The picture of an organic dementia in childhood seems likely to pick out speech first, as the most recently acquired and least stabilized achievement, the habits of cleanliness inculcated with some difficulty next, and to leave relatively untouched the more primitive motor functions. The same clinical picture was observed here in a 5-year-old girl, now in the Fountain Hospital for low-grade defectives, whose dementing illness followed an acute tonsillitis complicated by middle-ear disease and acute nephritis. Exploration of the lateral sinus, and cerebral puncture, as well as repeated lumbar punctures, seemed to make it clear that there was no direct spread of infection to the cerebral tissues. When seen at the Maudsley Hospital after recovering from her acute illness, previous to which she had been a normally developed and active child, she was mute, except for undifferentiated noises, which seemed to register very crude expressions of pleasure and displeasure. She ran round the room, interfering with all the objects within her reach, biting or sucking many of them, and biting, sucking, and destroying her own clothes. She was incontinent and apparently quite unaware of her physical needs. She would no longer feed herself, but her grace and perfectly controlled motor co-ordination and her animated expression, were essentially those of a normal 5-year-old girl.

No case in this series falls into the group of dementia infantilis, but two children

of striking appearance and behaviour can be reviewed here in comparison with this group and as a contrast to one another.

Hilda J. was first seen in 1932, aged 10 years, 10 months. There is no neuropathic family history. She is an only child. She walked at the age of 1 year and 4 months, talked at the same time, and was an over-particular child, easily trained in clean habits. She first went to school when aged 5, and is said to have liked it. Her illness had an indefinite onset when she was about 7 years old. She became afraid of other children, had "nerve attacks", during which she cried and showed fear, at the same time becoming very obstinate and talking to herself. At these times she disregarded her surroundings, but would become more or less normal again and return to school. She learned to read, according to her infant-school mistress, but would never join in fully with class work and would never read aloud or recite. With good intelligence in some respects, she seemed much inhibited in others. She never mastered writing or spelling. Early in her school years her sight was questioned; she peered at objects and worked at practical material as if she could not see clearly.

Yet she went about unaided and never walked into projecting objects. She was examined at a local refraction hospital, at the Royal London Ophthalmic Hospital, and at a neurological hospital; no visual defect could be proved. She was, however, never fully co-operative in the examination, and no detailed records of visual fields were available.

She became progressively less able to learn and the periods of difficult behaviour occurred more frequently. When seen here her posture was very striking, fixed, rigid, somewhat stooping, with a dull, expressionless face but no tremor. She performed certain stereotyped movements and gestures, would repeatedly comb her hair or turn over an object aimlessly when holding it. She could obey simple commands but an intelligence test could not be given, owing to lack of co-operation. Her "writing" was a meaningless scribble, and she had a very odd way of looking sideways at objects. There were at this time no objective physical signs. Her progress was closely watched until 1935, over a period, that is, of three years, during which time there was a slow deterioration. A phasic element appeared during the second year of observation with short periods of irritability, sleeplessness, tears and anxiety, alternating with moods of excitement in which she chattered and laughed without cause. At the same time, she began to menstruate somewhat irregularly. The unstable periods bore no certain relation to the catamenia, though twice the over-activity coincided with a period. She then walked about quickly, clapped her hands, scribbled letters to a wireless-band leader, and said once that Jesus had talked to her. In August 1934—two years after her first attendance—a double extensor response had developed; four months later optic atrophy was queried in one eye, and it seemed possible that her visual difficulties might have been associated with a central scotoma, and only diminished peripheral vision. Nystagmus was noted as present about this time. Her behaviour continued to be bizarre, with periods of excited chattering of a disorganized kind, though without dysarthria. She became so difficult as to need certification and is at present in a mental hospital, where her disorder is regarded as an aberrant type of Schilder's disease. Her condition is progressing slowly. She is now completely blind, the blindness being apparently of the cortical type. The discs are pale but not atrophic. At intervals she has epileptiform seizures. These began three years ago and were then infrequent; now they occur about once a fortnight. There are no localizing signs, and the convulsions are generalized and not in any way unusual. Her mood shows no swing. The periods of apathy and weeping are replaced by a more or less constant diurnal chattering. The pyramidal signs have become more marked, though very slowly, and there is now some generalized spasticity. Her habits are faulty, probably in association with the profound dementia.

In contrast with this case is the following:—

Ruth A., aged 9, seen first in July 1936. She is an illegitimate child, her appearance like that of a half-caste. Her mother is a healthy Swede, married, and with other children. Her father was little known to the mother, but is said to be a healthy European. She attended with the foster-mother who has known her since birth. After a normal infancy she had walked at the age of 1 year, was easily trained in clean habits, and before the age of 2 had learned to talk, but, according to the foster-mother, she then appeared to lose her speech. She was always an anxious, dependent child, afraid of other children. She went to school when she was 5, but when aged 8, was transferred to a school for mental defectives. With only this evidence, and hearsay early history, it is impossible to state whether she has been a backward child from birth, or, what seems more likely, is an

example of an early regression, of unknown cause, which had already produced a degree of mental defect by the time she was 8 years old.

When seen here her appearance was striking. She smiled constantly in a secretive and inappropriate way. She was almost mute but understood simple commands, and answered, "Yes", "No". Her fine manipulations of toys and bricks were normal, but there was a marked degree of negativism. She actively withdrew her hands when asked to hold them out, and showed mannered movements, a peculiar gait, and some stereotypy in certain of her movements and gestures. She appeared afraid, but burst into laughter for no apparent reason. During a period of admission, she remained entirely passive and quiet and throughout no physical signs were found, except a doubtfully positive Meinicke reaction in the blood-serum, with completely negative cerebrospinal fluid. She then passed into a phase of excitement and destructiveness and was accepted into an institution for the care of defectives. Her appearance now is strongly suggestive of a schizophrenia. She maintains a peculiar posture and makes repeated meaningless stereotyped movements. There is some perseveration shown in drawings; mainly she is unoccupied. She replies when questions are persisted in—with much scatter and a continuance of inappropriate laughter. The latest report confirms the absence of physical signs and continues:—

". . . (?) catatonic psychosis superimposed on defect. The history suggests the possibility of a pure psychotic origin."

For the conception of catatonic psychoses in mental defect the work of Earl (1934) is important in distinguishing clinical types. Again it is likely that the merging ground between the case with organic signs and obvious deterioration (the ament with superimposed schizophrenia) and the true primary psychotic will inevitably attain a common level of dementia, so that if, when they are seen first, they have reached that point, the different paths leading to it can only be inferred from the history.

Among the 35 cases here considered, a group can be singled out in which the schizophrenic illness is superimposed on a defect known to have existed from an early age. In four such cases there is a straightforward history of backwardness in school, and mental testing done with a fair amount of co-operation from the child gave intelligence quotients of 78, 66, 67, and 72.

In only one of these cases, a boy aged 15, with an I.Q. of 72, was there a clear history of backwardness in early development, and late acquirement of walking, talking, habit training, and so on. He was a timid, asthenic youth, with a small head and badly bitten nails. His psychotic condition had had no acute onset, but consisted in a gradual withdrawal of interest in his surroundings, with marked emotional instability so that he is liable to outbursts of temper on trivial provocation. It would probably be more correct to regard him as an emotionally unstable and immature ament.

Two others in this series, both girls, show results on an intelligence test which are of some interest.

Lily K., seen in 1935, aged 15, came with a history of increasingly irresponsible behaviour, truanting, and wandering at night. In addition she showed restless movements, and was regarded by her mother as quite unemployable.

An intelligence test, using Burt revision of Binet gave an I.Q. of 91 with much scatter; her reading and verbal ability were good, her arithmetic below the nine-year level. Her performance ability was so poor, that scored on a series of performance tests alone, her I.Q. was only 64. Her Rorschach profile was very interesting, with a large amount of confabulatory responses, and many oppositional responses. These findings were regarded as strongly suggestive of schizophrenia and against a diagnosis of feeblemindedness, although the latter was suggested by her childish irresponsibility and sexual precocity, combined with an entire lack of judgment.

Earl's work on test profiles (1937) points out the significance of test results with this distribution. In the average stable moron, the performance ability greatly exceeds that shown in a test involving a language scale (such as the Binet). In the unstable moron there is a great falling-off on the practical side, and this is

even more marked in the unstable or psychotic adult where the onset of the illness post-dates considerably the acquisition and stabilization of verbal ability. Where, on testing, the verbal ability is extremely low, compared with the practical—which was well shown in tests on Ruth A., the 9-year-old catatonic—it suggests that the onset of the illness may have been very early indeed. It will be remembered that in her case she is said to have acquired speech and then lost it.

Maud P., seen in May 1937, aged 14, was untestable except on performance tests. Here the results showed an extreme variation, for example, mental ages varying from 6 years on Koh's blocks to 13 years on Passalong. She has been a patient in a mental hospital since June 1937, and is there regarded as an unstable defective, with periods of apathy alternating with impulsive behaviour. Her school record indicates steady work, with some backwardness, but she was not thought to be backward in her early development. Clinically this case is a good illustration of the no-man's land which exists between the clear-cut picture of amentia and psychosis.

In considering whether or not mental retardation is present in cases seen for the first time when some deterioration has already taken place, some stress is naturally laid on the developmental stages in the early history. This can be confusing and misleading, if only because an exact record is rarely kept, and standards vary widely. In this connection a valuable addition to the literature is the diary kept by the intelligent mother (a school-teacher) of a boy who developed a psychosis at an early age.[1] It is an intimate record of the development and behaviour of the boy—a first child—from birth until the age of 4 years and 9 months. Tramer regards the diagnosis as certainly an early schizophrenia, running a prolonged course, with partial remissions, and lacking the essential features of a dementia infantilis. The development is analysed with special reference to intelligence, affect, and motor behaviour.

The child's capacity to notice and respond and, particularly, his speech, were earlier than the average. There was a lag in motor development, but as this was also associated with delayed teething, it would seem as if physical factors might have a bearing. In any case, the retardation was not serious, and he was walking at the age of 18 months, but a certain caution, and unwillingness to adventure, marked his motor development from quite early days. For instance, although when 1 year and 9 months old, he would run rapidly from one room to another, he was still unwilling to seat himself on the ground and pick himself up again. He avoided such situations in his play, or looked for help from his mother. In his affective development, the greatest and earliest departures from normality were shown. He was somewhat readily upset by new people, and by occasions such as a journey; excitement so aroused usually produced sleeplessness which became a marked symptom later in the illness, so that it seemed as if this pattern, or habit, of registering a reaction to some disturbance was early laid down.

In our series, sleeplessness was not a prominent feature except during or at the onset of an acute attack of illness. But in two cases of an insidious schizophrenic illness, with bizarre ideas and a wealth of fantasy, both children had slept badly as babies, and had always been restless and easily disturbed throughout childhood.

From the end of the second year onwards, the diary indicates a progressive falling-off. The boy's capacity for learning and adapting reaches a standstill. His play shows a marked stereotypy; he disregards toys, playing only with one animal which he uses for everything, and later with a sofa cushion. He becomes unable to meet other children, ignores their presence, or actively runs away from them. When later (aged 3 years and 9 months) he attended a kindergarten and was coaxed into a group, he was quite passive on the rare occasions when he let himself be included in a game. He came to speak hardly at all, but occasionally would bring out a perfectly normal sentence. During the third year, phases of greater activity and liveliness, though still with little directive control, alternated with periods of extreme apathy and anxiety in any new situation, even a strange room. His speech deteriorated in articulation, apart from mutism associated with negativism, and he

[1] The diary is published in full with accompanying observations by Tramer (1934-6).

often uttered meaningless shrieks and cries. His final state was a profound dementia reached between the ages of 6 and 7, and at 12 he remains a case in institutional care. But a remarkable point is to be noted that at the age of 12 a double extensor response was obtained. This was regarded by Tramer as an indication of a complete regression, psychological and now physiological, to the infantile state. All other signs in the central nervous system were lacking, and although the boy's behaviour included only the simplest forms of repetitive movement, he could still walk and run, and all other reflexes were normal and equal.

One can only say that such a finding is unusual in a schizophrenic dementia.

The value of this work lies in the unedited observations of the mother. In interviewing parents of children with serious mental disorder, remarks are so often prefaced by, " Now I come to look back, I realize so and so ", suggesting that in the light of the fully developed disturbance a new interpretation is put on events which at the time passed without comment. Until well on in the third year, this mother had no idea that the small points she noted were stages in the development of an irreversible pathological process. Since, however, this problem of the psychotic child remains such a pressing one, it seemed worth while to study our records very particularly with regard firstly to the age of onset of symptoms, and secondly to the previous personality. In such small numbers it is difficult to group since there is much overlapping. But it seemed clear that certain phases of stress occur.

Of the 35 cases, the onset of definite symptoms, for which advice was sought, in all but nine, lay between the ages of 13 and 15. These nine cases were of earlier onset. Ruth A., already described, showed symptoms in early childhood. Heather N. (11) showed a definite reaction of withdrawal and hostility following the unexpected death of a much-loved father, and has since made a good adjustment. Basil L. (12) had attacks of violent excitement with hallucinosis and a history suggestive of migraine. It seemed likely that these might prove to be major hysteria, and pending a further period of observation the diagnosis is left open. But he is a capricious and fanciful youngster, never able to make friends of his own age, somewhat precocious and a butt for teasing. William B. ($12\frac{1}{2}$) had an almost paranoid reaction against his home, for reasons which were never made clear, since he refused to discuss it. He, too, has made a good adjustment. These three might perhaps be regarded as having at least a considerable reactive element.

Of the remaining five, three are in boys—aged 10, 12, and $12\frac{1}{2}$, respectively, all with a long history of shy, seclusive personality, with poor social adaptation and much teasing at school. The fourth is in a girl, Mina S.; and is very well known to me.

A fully developed catatonic schizophrenia was observed when she was aged 12 years and 6 months and there was a previous history dating back at least two years.

Unfortunately her mother kept no diaries, but she has discussed very fully with me the early years. M. was a phenomenally good child with normal developmental attainments. Somewhat aloof, she was very good at playing by herself.

" Not a tomboy " (I quote from the mother). " We used to call her a quaint little girl. She was dainty and fastidious, and devoted to her mother and father, but at school was always teased because she minded it, and couldn't stick up for herself." A sense of strain and severe difficulty in school was noted at 10, and she ceased to learn. Attendance at a special (M.D.) school was recommended but the parents paid for private schooling. She became gradually quieter but was always a little nervous of school, and of other children, and finally she ceased to attend. During this time she developed outbursts of screaming if upset, especially if criticized adversely. She began to menstruate so early ($11\frac{1}{4}$) that no instruction on the subject had been given to her, but she made no comment nor did she tell her mother, who only discovered the fact by the stained bed-clothes. The child accepted explanations quite passively, was fastidiously clean, and remained secretive about this function; although she was not regarded as ill enough for advice to be sought until she was 12 years and 8 months old this suggests that already some emotional apathy, or severe repression, had set in. She rapidly developed into a catatonic state, negativistic and resistive,

and the only words I ever heard her say were, "Go away, leave me alone". When left alone, she frequently smiled to herself. She is now (aged 15½) aurally hallucinated, resistive, almost inaccessible.

The fifth case was in a boy aged 11, and is discussed in connection with the affective psychoses.

In the remaining group of 27 cases, the onset of symptoms coincided with puberty in two girls and two boys and, perhaps characteristically, was associated with unrestrained overt sexual activity and excitement in the girls, and with somewhat anxious hypochondriacal fears and fantasies, associated with masturbation, in the boys. In two cases a temporary paranoid reaction was observed, one to a mastoid illness, and one to the strain of facing employment, in a girl crippled and deformed, with a healed tuberculous spine. The girl made a good adjustment, but the boy has not been traced. In four cases, two girls and two boys, all somewhat irresponsible, and slightly retarded intellectually, the strain of leaving school, where life is ordered and controlled, and having to seek and keep employment, seemed to act as a precipitating factor. One is untraced, but the other three, all of whom became ill at the age of 14, shortly after leaving school, have maintained a good adjustment alongside suitable employment of not too exacting a nature.

I realize that I have left untouched the problem of cases showing marked mood-swings, and it may appear as if the possibility of manic-depressive illness in childhood had been cursorily dismissed. The problem of the affective psychoses in childhood is, however, even further from solution than that of schizophrenia, since the cases are of rare occurrence, and in some instances appear to merge into a more definitely schizoid reaction. Should these be regarded as instances of schizophrenic illness with mood-swings, or does the severe emotional disturbance of a manic-depressive attack predispose the child to a more profound splitting of what is, as yet, an only partially integrated personality? It has been shown how far a schizophrenic type of thinking and behaving is natural to a child, as also is the display of emotional disturbance, which is so relatively easily aroused.

Ziehen (1917) points out that excitability, motor restlessness, and a flow of talk are usual occurrences in excited children, and hence such phases may only come to be regarded as incidents in a manic-depressive illness when the condition becomes clearly manifest in later years. Homburger (1926) devotes a lecture to this subject in his "Psychopathology of Childhood", and says there, that in the same way, the depressed child may readily be thought of as physically sick, since he lacks the capacity to analyse and express his sense of discontent with the world. Certain it is that children will meet, as Homberger points out, endless occasions in the environment which will tend to produce extremes of joy and sadness, and it seems all the more remarkable that a shift-over into the pathological degree of excitement or depression occurs so rarely.

In this series three children showed marked emotional deviations.

One boy, aged 15½, became depressed on losing his job, and a girl aged 14 showed rapid change from depression and apathy to elation and over-activity. Both, however, showed alterations of personality consistent with a schizophrenic illness. The third, a boy aged 11, had an illness which began at the age of 9. There is no history of manic-depressive illness in the family, but an alcoholic history on the paternal side. The degree of alcoholism in the father was not severe, and his relationship with the children, as well as with the mother, was happy, although somewhat intense. An elder brother had broken down completely with a stuporose catatonic condition shortly after his father's death. A second attack, in which he was seen recently, was a typical catatonic excitement. The younger 11-year-old sibling presented a problem in diagnosis for at least two years, although now—three years after the original illness—the condition is probably schizophrenic. He has been observed, however, in just the phases described by Homberger and Ziehen. When depressed, he was regarded as only unusually quiet. But if questioned, he would express self-reproachful ideas, and though rarely tearful, he would display a complete lack of interest

in his surroundings, and his expression was at these times one of tragic despair. His self-reproachfulness related to guilt over sexual curiosity. Periods of over-activity were, however, more frequent. He would then talk to excess. His speech was clear and coherent; he showed flight of ideas and sometimes rhyming and punning. His behaviour was extremely restless and mischievous and showed a remarkable eroticism, with particular interest in his mother's body. His expression was lively, and his movements quick, active, and supple. The intervening periods of normal balance showed traces both of the eroticism, and of the tearful self-reproachfulness.

That these two brothers should tend to react in this way might almost have been predicted from their early history, which was very fully given by the mother. The elder (catatonic) was a fat and placid baby, intelligent but somewhat inert. He grew to be an abnormally sensitive child, who could never take a beating, and could at any time be teased into tears by his father. His attachments to people were never very obvious, he remained reserved on the subject of his father's death, and the only evidence of strain was shown in his tendency to extremely obvious boasting in matters where he felt his insecurity keenly. This aroused much comment, for instance during his first term at school. The younger boy was from birth an over-active and demanding child, who gave ready expression to all his moods, both of pleasure and displeasure. He was cheeky and friendly, his sociability overriding all ordinary barriers. He showed a marked preference for friendships with boys, but was extremely demonstrative in his affection for his mother, often biting her cheek or rubbing against her breasts.

The heredity and environmental stress in these boys has been almost identical, but for a time their psychoses were barely recognizable as instances of the same disease. Now the elder is in a period of intermission, while the younger varies between a state of disordered excitement and a pronounced degree of dullness and apathy with occasional outbursts of agitation. His progressive lack of interest is manifest even during periods of intermission.

In so far as the findings can be summarized, out of the 35 cases considered, 12 remain ill and unfit to work, five at home and seven in mental hospitals; 14 cases have improved or are having good remissions, three of these 14 have had long periods of hospitalization, and only one of them improved after treatment with cardiazol; nine remain untraced. Since these 35 are selected out of a total number of juvenile discharges over the period considered, of 1,265, the great rarity of psychoses in children is demonstrated, the proportion being about 2·8%.

This is obviously no more than a tentative survey of what becomes a larger and more intricate problem at each stage of the inquiry. The question of heredity has been left untouched as also that of treatment, either prophylactic or of the acute attack. The omissions do but indicate the tremendous field here for observation and research.

I am greatly indebted to Professor Mapother for his permission to publish this material.

REFERENCES

Burger-Prinz (1935), *Nervenarzt*, **8** (II), 617.
Campbell, C. Macfie (1935), "Destiny and Disease in Mental Disorders", London.
Earl, C. J. C. (1934) *Brit. J. M. Psychol.*, **14**, 230.
Id. (1937), Personal Communication.
Heller, T. (1909), *Ztschr. f. d. Erforsch. u. Beh. d. Jugendl. Schwachsinns*, **2**, 17.
Homburger, A. (1926), "Psychopathologie des Kindesalters", Berlin.
Kanner, L. (1935), "Child Psychiatry", U.S.A.
Kasanin, J., and Kaufmann, M. (1929-30), *Am. J. Psychiat.*, **9**, 307.
Kasanin, J. (1931), *Am. J. Psychiat.*, **10**, 879.
Kraepelin, E. (1913), "Psychiatrie", Leipzig.
Mayer-Gross, W. (1921), *Ztschr. f. d. ges Neurol. u. Psychiat.*, **69**, 332.
Piaget, J. (1929), "Child's Conception of the World", London.
De Sanctis, S. (1906), *Riv. Sper. di Freniat.*, **32**, 141.
Tramer, M. (1934-5), *Ztschr. f. Kinderpsychiat.*, p. 91 *et seq.*
Id. (1935-6), *ibid.*, p. 17, *et seq.*
Wildermuth, H. (1923), *Ztschr. f. d. ges. Neurol. u. Psychiat.*, **86**, 166.
Zappert, J. (1922), *Monatschr. f. Kinderh.*, **22**, 389.
Ziehen, T. (1917), "Die Geisteskrankheiten des Kindesalters", Berlin.

Section of Medicine

President—H. L. TIDY, M.D.

[*January* 13, 1938]

DISCUSSION ON CERTAIN ASPECTS OF THE ASTHMA PROBLEM

Dr. Francis M. Rackemann (Boston, Mass., U.S.A.): Asthma is a symptom. It has so many causes and so many varieties that it is probably not wise to regard it as a disease entity. In most cases, asthma depends upon a certain form of allergy, but so far it is not certain that all cases of asthma have this allergic background. The asthma problem in general is important, for two very practical reasons. First, the asthma symptom is one of the common manifestations of illness, and the suffering which it produces may be of maximum severity. Secondly, asthma and other manifestations of allergy depend not upon the nature of the infecting agent, but upon a peculiar reaction of the host. To know why it is that only 2%–5% of the population have the capacity to develop clinical sensitiveness would imply and would lead to a great advance in the knowledge of immunity in general. The new knowledge would explain why a man is a little more like a rat than like a guinea-pig; the rat is sensitized with great difficulty, the guinea-pig with ease and considerable regularity.

Hay-fever, asthma, and eczema are often due to foreign substances to which the patient is clinically sensitive. Contact with that substance or other substances, results in tissue reactions of the immediate urticarial type. Such reactions are typical of allergy and in most cases can be reproduced artificially on the skin, or on the mucous membranes, at any time. These reactions, however, also occur under other conditions which are recognized as normal. When animals are treated with various foreign sera, they become sensitized and, within certain experimental limits, skin tests with the sensitizing protein will produce responses of the immediate urticarial type. Similarly, when man is treated with foreign serum, the immediate reaction to that serum can be demonstrated after an incubation period. In certain infectious diseases, and notably in disorders due to infestation with worms, immediate reactions with the carbohydrate fraction of the bacterium or with the extract of the worm are demonstrable regularly. In other words, the reactions of clinical allergy, which are so dramatic and typical, may be little more than the exaggeration of a response which is normal, and it may not be necessary to search for any very elaborate mechanism. At the same time the drama must be explained. If the process is normal, and the urticarial response is a natural part of it, one still has to find out why it is that in persons who are "allergic" the process does not continue on to complete immunity.

Meantime, the word "allergy" is used in another sense to describe other reactions of delayed inflammatory type, characterized by the tuberculin reaction. However, the two kinds of reaction are related, for Zinsser (1921), Dienes (1931), Jones and Mote (1934), and Simon and Rackemann (1934) have shown that when a guinea-pig is given a series of daily intracutaneous doses of a protein like egg-white or horse-

serum, there develops after the first few days, a reaction of the delayed inflammatory tuberculin type, but later, some time after the seventh day, the response becomes of the immediate urticarial type, and so it is concluded that the delayed inflammatory reaction is the early phase ; the immediate urticarial reaction is the late phase in the normal process of immunity.

In some ways, however, clinical allergy *does* differ from the normal. First, the degree of sensitiveness is often exquisite, as shown by the bizarre experiences of many patients. Second, sensitiveness is directed ordinarily not to a single substance, as in the anaphylaxis experiments, but to a variety of substances at the same time ; it is multiple. More important, however, is the third point that the capacity to develop sensitiveness which seems so fundamental is something which is inherited in about half of the cases, and the fact suggests some inherent congenital defect of the immune process itself. Coca (1923) lays great stress on the inheritance of clinical allergy and uses the word " atopy " to describe this strange disease dependent upon " atopic " reactions to " atopens ".

There is one additional point sometimes overlooked in discussions of the analogy between artificial anaphylaxis and clinical allergy, and this concerns the symptom asthma. To treat an animal so that it will show a positive reaction when later the specific substance is applied to its skin is not difficult, but to reproduce in the animal the picture of clinical allergy in the human has not so far been accomplished, even though Alexander (1926) and Ratner (1925, 1927) have produced asthma by exposing sensitive guinea-pigs to the antigen applied as a spray in a closed chamber. It is to be noted that in these experiments, the doses were relatively large. After injections of horse-serum into man, positive skin tests will develop in a considerable number of cases. Indeed, Hooker (1924) has claimed that 27% of children treated with the diphtheria toxin-antitoxin mixture will develop later a positive skin test to horse-serum. However, the development of clinical sensitiveness is rare. A group of bakers was studied by Colmes, Guild and Rackemann (1935) in my clinic. Many of these bakers were found to give positive skin tests to wheat, but only one man out of 32 had become clinically sensitive to flour. The fact suggests that some factor other than sensitization alone is necessary for the development of clinical allergy. One wonders whether Coca's description of " atopy " as a subgroup—a special form of " allergy "—may not be a useful designation, and in the clinic it seems to be so.

The symptoms of clinical allergy or of " atopy " depend upon contact with the offending substance and the immediate reactions resulting from this contact. In hay-fever the local tissue response is typical and easy to understand, but in asthma there are difficulties in the way of visualizing a direct contact between the foreign substance in dust and the mucous membrane. We see symptoms in the nose and symptoms in the chest, but we rarely see symptoms in the larynx as would be expected in the case of a direct extension of the contact. Abdominal symptoms may occur, and occasionally headache can be explained on the basis of food allergy. In each case, the patient presents evidence that one tissue is more sensitive than other tissues. Coca's description (1923) of the " shock organ " is pertinent. One is forced to consider that the cause of these remote symptoms is something which reaches the tissue through the blood-stream and, in line with this, is a group of interesting experiments which aim to demonstrate the presence of foreign substances in the blood. Prausnitz and Küstner (1921) made the original observation that the blood of sensitive persons contains an antibody which can sensitize locally the normal skin of a normal recipient. This local sensitiveness can be demonstrated in various ways other than by the direct injection of the foreign substance into the sensitized spot, and this demonstration is useful here. Walzer (1926) was the first to observe that in case the serum used was obtained from an individual clinically sensitive to egg as food and then if the normal subject treated with that serum ate egg, within a few minutes an urticarial reaction would appear spontaneously on the sensitive area on his arm. Another experiment

was that of Gay (1927) who demonstrated that when an area in one arm is sensitized with serum, the spot will react if the antigen is injected into the other arm. He called it a " contra-lateral " reaction. Finally, Cohen (1930) could show that a spot sensitized with serum from a patient sensitive to ragweed will react in about twenty minutes after a quantity of ragweed pollen is inhaled. It appears, therefore, that the antigen can enter the blood through the respiratory tract, the gastro-intestinal tract, or after subcutaneous injection, and each of these three experiments provides evidence that in case foreign protein does enter the blood, it can remain there unchanged, at least for a time. (As a matter of fact, the " digestibility " of different proteins varies considerably.) Meantime, Alexander (1936) has demonstrated that when normal dogs are fed on egg-white, it appears promptly in the thoracic lymph and later in the urine. One can say then, first that particular cells and tissues are sensitized specifically, and second that the antigen can reach these cells in whatever part of the body through the blood-stream. But is the allergic reaction by itself a sufficient explanation for the whole clinical picture ?

There is a group of patients who have asthma of maximum severity and who are almost impossible to treat successfully. Intractable asthma is always a problem. The patients gasp for breath, to be sure, but they also show other symptoms—sweating, cold extremities, low blood-pressure, rapid pulse, dilated pupils. They cannot eat, they look sick, and they are sick. They seem to be different from those other patients who have merely a sudden acute attack of typical extrinsic asthma. The illness in these intractable cases forces the thought that they have a sort of poison in their blood and one wonders whether the differences between these cases and the simpler more ordinary cases, are merely quantitative or qualitative.

In this connexion, the pathology of asthma is interesting. Dr. Tracy B. Mallory of the Massachusetts General Hospital (1938) has now examined a series of patients who died in an acute attack of uncomplicated asthma. The detailed study of his findings will be published shortly, and the following paragraphs are based largely on his work and written with his approval. At autopsy, the lungs are found to be distended and fixed, precisely like the lungs of guinea-pigs dead in anaphylactic shock. The lungs form a perfect cast of the chest cavity. On cut section, one sees the formation of tough sticky plugs which protrude beyond the cut surfaces and which can be grasped with forceps and pulled out in a long stringy mass. The clinical evidence that this plug formation is the true lesion in asthma is strong, for the sounds in the lungs heard with a stethoscope will vary from place to place and from time to time, changing markedly with cough, obviously because the cough has dislodged one of the plugs. Lipiodol often provides a beautiful demonstration. Under the fluoroscope, the opaque material can be seen to descend readily to the medium-sized bronchi and there to be sharply obstructed, often with a concave end, as though the lipiodol fitted over the rounded head of a plug. Not all the bronchi are obstructed at the same time and it should be emphasized that in any one bronchus, the plug is a temporary formation. When the plug is complete, one finds evidence of a local collapse in the portion of the lung aerated by that bronchus, but when it is incomplete the partial blocking provides a ball valve which lets air in easier than it lets air out and so produces emphysema.

The appearance of the bronchi under the microscope is very instructive. The bronchial muscle is obviously thickened, but whether this represents a true hypertrophy or merely a contraction of the muscle is open to question. It is not more marked in the long-standing than in some of the acute cases. However, the essential lesion appears to be a hypertrophy of the mucous glands in the bronchial walls. Evidently these glands are very active and pour out a quantity of mucoid material full of cellular débris. Fibrin forms in this débris to give the plug its real substance. The lack of evidence for any inflammation around the outside of the bronchus, in spite of the lesion within, is a striking feature.

Why do the bronchial mucous glands become hypertrophied and over-active? It is conceivable that a local allergic reaction, taking place in the glands, could in some way cause the stimulation. On the other hand, glands can be stimulated readily by nerve action, and one thinks of some nerve mechanism reflex in character. The close relation of asthma to disease in the nasal sinuses suggests this, but this relation is so close that I for one like to think of the sinus lesion, which simulates the bronchial lesion so closely, as a part of the picture rather than as a cause of it. I suggest that whatever the fundamental disturbance in asthma may turn out to be, it is something which affects the bronchi and the sinuses at the same time. Operations on the sinuses do good in a few cases; that is true, but usually the effect is temporary only, and it is always possible that the good effect depends upon the non-specific disturbance of the operation itself. The theory of nerve activity is hard to support except in so far as the activity of autonomic nerves is closely concerned with the release of chemical effectors in the tissues.

Whether all the findings can be explained by the local allergic reaction in the tissues is doubtful. The symptoms of shock and prostration seen in severe asthma might represent merely an extreme exhaustion of the patient, but on the other hand, the new knowledge of chemical effectors leads to several attractive possibilities. Perhaps the organism is flooded by an excess of some cholinergic substance like histamine or acetylcholine arising in the local process. Schild (1936) has shown that in guinea-pig anaphylactic shock the intensity of the reaction and the amount of histamine liberated by the reacting lung do bear a direct relation to each other, but on the other hand the bronchial contraction produced by barium chloride is not accompanied by the release of any histamine at all. The rôle of the histamine is still obscure. Perhaps the body lacks the normal ability to destroy cholinergic substances, even though in the few cases studied so far the choline esterase has been found to be increased in asthma. Finally, it may be that the body is changed in some way so that it reacts to these substances in an abnormal fashion.

These are random thoughts without, so far, much evidence to support them, but they are offered in the hope that in the near future a new light will be thrown on a problem which is fascinating in its immunologic aspects and of the greatest practical importance to countless individuals who suffer from the manifestations of allergy. The present status of the asthma problem is summarized by a recent remark of Lewis Webb Hill (1937): "The removal of those allergens to which a patient is found to be clinically sensitive is a surrender to a bad situation rather than a direct attack upon it." To this problem of asthma and allergy, the work of such men as Sir Thomas Lewis, Sir Henry Dale, and Professor Cannon, is of primary value, and those of us who are responsible for the comfort and welfare of many patients must look to these investigators and their associates for advice and help; I am sure that we shall not look in vain.

BIBLIOGRAPHY

Alexander, H. L., Becke, W. G., and Holmes, J. A. (1926), *J. Immunol.*, **11**, 175.
Alexander, H. L., Shirley, K., and Allen, D. (1936), *J. Clin. Investigation*, **15**, 163.
Coca, A. F., and Cooke, R. A. (1923), *J. Immunol.*, **8**, 163.
Cohen, M. B., Ecker, E. E., Breithart, J.R., and Rudolph, J. A. (1936), *J. Immunol.*, **18**, 419.
Colmes, A., Guild, B. T., and Rackemann, F. M. (1935), *J. Allergy*, **6**, 539.
Dienes, L. (1931), *J. Immunol.*, **20**, 221, 333.
Gay, L. N., and Chant, E. (1927), *Bull. Johns Hopkins Hosp.*, **40**, 270.
Hill, Lewis Webb (1937), *J. Allergy*, **9**, 37.
Hooker, S. B. (1924), *J. Immunol.*, **9**, 7.
Jones, T. Duckett, and Mote, John R. (1934), *New England J. Med.*, **210**, 120.
Mallory, Tracy B. (To be published.)
Prausnitz, C., and Küstner, H. (1921), *Centralbl. f. Bakt.*, **86**, 160.
Ratner, B., Jackson, H. C., and Gruehl, H. L. (1925), *Proc. Soc. Exper. Biol. and Med.*, **23**, 17.
Id. (1927), *Amer. J. Dis. Child.*, **34**, 23.
Schild, H. (1936), *Quart. J. Exper. Physiol.*, **26**, 165.
Simon, F. A., and Rackemann, F. M. (1934), *J. Allergy*, **5**, 439.
Walzer, M. (1926), *J. Immunol.*, **11**, 249.
Zinsser, H. (1921), *J. Exper. Med.*, **34**, 495.

Professor L. J. Witts: After five years' work at the Asthma Clinic at Guy's Hospital I remain very much dissatisfied with the treatment of asthma. It is possible to establish a *modus vivendi* with the disease, whereby one attempts to desensitize those who show positive skin reactions, gives vaccines to those with respiratory infections, and uses some form of shock therapy in that not unimportant group in which neither skin sensitivity nor respiratory infection is demonstrable. As a result of such technique, one earns the gratitude of many patients, who attribute their improvement to the treatment, but the results are discouraging when they are analysed in the light of the natural history of the disease. It is of course true that our investigation of patients is rarely as elaborate as it might be. Many American books on allergy read like a detective story. One sees the allergist studying the most intimate details of the patient's life, entering his bedroom and holiday camp, placing in position his greased slides and Petri dishes, estimating the leucopenic index and supervising an elimination diet, until the offending allergen is tracked down. Like psycho-analysis it makes exciting reading, but it is difficult, if not impossible, to apply on a large scale in practice. In any event the detection of allergens is very different from the cure of asthma. In an important paper Dr. Rackemann has described how he followed up a series of patients apparently cured of asthma and found that many had relapsed and were getting asthma from new stimuli and allergens. In a memorable simile he stated that the gun was still loaded and a fresh trigger was firing off the attacks. All of us must have seen asthma vary when exposure to allergens was apparently constant, and many of us have seen striking effects from psychotherapy and physical exercises. The soil in which asthma develops is more important than the seed which induces attacks. Adrenaline and ephedrine have done at least as much to relieve asthma as the discovery of allergens, and future advances appear more likely to come through measures destined to modify the soil than through the discovery of more and more allergens capable of exciting the paroxysms.

Dr. E. R. Boland (*Abridged*): Disentangling the truth about the results of the treatment of asthma, in the present state of therapy, is like fumbling in a nightmare.

The so-called specific treatments for asthma are widely disparate both in practical application and in theoretical basis, and yet the same effective results are claimed for all of them. Even an individual method of treatment such as vaccine therapy or protein desensitization is applied by different workers in ways which are poles apart, although nominally the same, yet much the same results are obtained by all. It would appear that all treatments are equally effective or else equally ineffective.

Professor Witts, my predecessor at the Asthma Clinic at Guy's Hospital, with the assistance of Dr. E. T. Conybeare, took the first steps to clarify the position and find out how much improvement could genuinely be ascribed to a particular line of treatment and how much to general treatment and other factors. They had the idea of forming a controlled series of cases which might act as a yardstick by which the results of specific treatments could be measured. Their group of cases was small but carefully studied; all the members were given general treatment, with advice as to the avoidance of suspected allergens, the best use of drugs, the rearrangement of their lives and diet, and so forth, and at the same time they were given injections of normal saline with all the parade of a specific treatment.

At the end of two months these workers assessed their results and found that almost half of the patients had shown definite improvement and a fifth had almost complete remission. They further studied the group showing improvement and found that after six months of this treatment two-thirds had secured almost complete remission.

These results were striking and justified a continuation of this attempt to establish

control of therapeutic results. We took steps to tighten our control and to increase the accuracy of assessment. No cases were admitted to our next series in which there was likely to be any difficulty of assessing improvement or otherwise. That is, the attacks were either frequent and of long duration, or else were so regular in their appearance over a long period that any amelioration would be easy to detect. We assessed the severity of the condition in all our patients, and put them into groups according to the frequency and severity of the attacks. Group 1 consists of patients who were having constant asthma and were unable to work ; group 2, of those having constant asthma but able to work three-quarters of the time ; group 3, of those who have at least one attack a month ; group 4, of those who have less than one attack a month ; group 5, of those who have had no attacks for a year and have had no active treatment for six months. In our final assessment no improvement was considered which did not promote a case from one group to another, thus representing a substantial change for the better.

We next studied cases in which mixed inhalant proteins were substituted for the normal saline, the general treatment remaining the same as before. Almost the same percentage of improvement was found in these cases as in those treated only with normal saline. We then studied a group in which remedial exercises were substituted for the normal saline or the protein for desensitization, and found that about two-thirds moved up at least one group.

To summarize our findings so far : Our experiments appeared to show that normal saline was as successful in the treatment of asthmatics as was the method of protein desensitization employed. They further seemed to show that remedial exercises added to the general treatment were more successful than general treatment in addition to either desensitization or normal saline.

We then instituted a period for observation for a minimum of two months, during which the patients had general treatment with exercises added as a part of their general treatment. At the beginning and end of this period the groups were assessed and were sent for protein desensitization. Only three out of the 25 so far included in this group showed any improvement while having desensitization, and two out of the three were below the age of 13.

We have now started a series in which injection of normal saline is substituted for the protein of the last group. I am unable to state the results as yet, but they should prove an interesting check on the last group described.

We are investigating the effects of vaccine therapy in the same manner and, although incomplete, the results so far do not appear likely to be significantly different from the meagre results obtained from our attempts at protein desensitization. It is true that all our groups are small, but they have been made so deliberately, and in their smallness there is strength rather than weakness, since they represent the sifted residue of hundreds of cases less suited for observation and are a sort of corps d'élite, selected not according to their severity only but also according to their suitability for observation.

Our findings, of course, are only valid for the patients treated at our clinic by the methods employed there, but these are not radically different from those employed elsewhere. They are subject to all the errors of human origin, but we have done our best to eliminate these so far as is possible, and all the assessments have been done by myself and Dr. Lintott, both independently and together. It is difficult to resist the conclusion that over half of the patients suffering from asthma show improvement under general medical treatment alone, and that if this is taken into consideration, as it must be in the assessment of the results of a specific treatment, much of the improvement now credited to specific methods of treatment is not due to them at all.

This position is widely different from that inculcated by some textbooks, and apparently held by some doctors not specially concerned with the treatment of

asthma, whose attitude is illustrated by the letters sent to me with the patients to whom they refer, the tenor of which can be summarized as follows : " Please investigate and identify the cause of this patient's asthma by means of skin tests and arrange for desensitization or vaccine therapy as indicated." They believe that one can carry out a few dozen skin tests, read off the results, find the cause of the patient's asthma, and abolish his sensitization, or else identify the offending organism in the sputum and cure him with a vaccine. The ideas are sound and attractive, but how far is theory from practice !

In these brief remarks I will avoid the thorny subject of the value or otherwise of skin tests and will content myself with quoting the words of Professor Rackemann : " Sometimes they are conclusive, frequently they are helpful, but often they are of no use and may even be misleading." I endorse each phrase, although I would, myself, put the last more strongly.

Supposing one has found an offending allergen from clinical study or by skin tests, what chance is there of desensitizing the patient to it if it cannot be eliminated ? I have my own view, but will only say that controlled observations show that the chances of such desensitization are much smaller than is generally thought, even when the sensitization is a simple one—which is rare, and not a compound one—which is common.

Our findings, while encouraging us to try to improve our methods of attempting desensitization or to find more effective ways of giving vaccines, show that our goal is not yet in sight ; they should stimulate us to make a closer study of individual attacks and their causation. Perhaps better results would be obtained in desensitization if skin tests could be made more reliable and if all workers were able to adopt a common technique, to standardize their interpretation, and to stabilize the preparations used for tests and desensitization so that we could all talk in the same language.

Only by clarifying our methods and controlling our observations will there be any chance of directing our efforts with the precision of a sharp-shooter, instead of, as at present, discharging in the vague general direction of the target our therapeutic blunderbusses.

Dr. L. S. T. Burrell said that the tendency to asthma often stopped for a time and then recurred without any apparent reason.

A subject sensitive to one substance was usually sensitive to several substances, so that desensitization very rarely succeeded.

It was the psychological aspect to which he would like to refer, and in this connexion he might mention the case of a hospital resident who had a severe attack of asthma one morning and was going back to bed when he had a message that his mother had been taken dangerously ill. He took a car at once to go to her, and when about twenty miles out of London, he suddenly remembered about the asthma, which had disappeared, whereupon he began to get dyspnœic again.

Another case was that of a woman who had asthma every time she went to Waterloo Station. As she lived on that line she had to go there whenever she went to London. This patient was told that the dust at the station had a tendency to give asthma to certain patients but that she could easily be cured by an injection containing this dust. She was given an injection of saline, after which the attacks of asthma ceased. This was a case of pure suggestion.

It had been said that the longer a patient kept free from asthma the less the tendency, but sometimes after freedom for many years asthma would return. A child who had been eighteen months in Switzerland, where he was quite free from asthma, had a severe attack the day after leaving, when passing through Paris.

Mr. Frank Coke said that though England could lay claim to being first in the field of allergy in virtue of Hyde Salter's beautiful description of his own cat asthma, America had brought the work to full usefulness, and he was pleased to have the opportunity of having heard an exposition of the American views on the subject by no less an authority than Dr. Rackemann. He did not subscribe to the very pessimistic views put forward by some of the other speakers and considered that in the English work there were three points of notable value.

Firstly, the fact that by giving adrenaline with the desensitizing doses of protein, much larger doses could be given and full results much more quickly obtained. Secondly, the differential sedimentation test enabled one, from a few c.c. of blood, to place the case into the allergic, microbic, or the aspirin-sensitive type. Such subdivision would be of great value in the treatment of cases by any one form of treatment, such as gold. The results obtained could be tabulated as referring to one or other of these three very different types of asthma.

Lastly, great advances were being made in the treatment of the microbic type of asthma, the offending organisms coming largely from the post-nasal swabs, so that by means of vaccine treatment even the aspirin-sensitive type was now curable.

Dr. Rackemann (in reply): This discussion has been very helpful, and I only wish that all of the men interested in this field could be as careful and critical. I am glad Professor Witts agrees that from now onwards the important problems in allergy will be in the domain of physiology. I am delighted to have Dr. Boland so critical, but I think that he should give us just a little more credit. In appraising the results of the treatment of asthma there are two chief difficulties. One is that asthma is merely a symptom which may depend upon any one of many causes, and that whereas the results of treatment in one kind of asthma may be very poor, in another kind they may be quite good. The second point is that specific treatment is always specific. The patient may give skin reactions to many substances at the same time—to several animals for example—and yet if his asthma depends upon his cat, no amount of treatment with horse-dander extract will do much good.

This principle of specificity is shown particularly well by some recent observations which we have made on moulds. A patient was so sensitive to tomato-leaf mould that he could not go into a tomato greenhouse without developing hay-fever and asthma at once. He was found to give beautifully positive skin tests to *Cladosporium Fulvum* but he reacted not at all to six other species in the *Cladosporium* genus. The degree of specificity was high, and in his case the treatment with *Cladosporium Fulvum* extract brought a marked improvement, so that after such a short course as only seven doses the man was able to enter the tomato greenhouse and remain there for some minutes without difficulty. If the extract used is specific, the results may be almost remarkable.

Section for the Study of Disease in Children

President—T. TWISTINGTON HIGGINS, O.B.E., F.R.C.S.

[*January* 28, 1938]

Enlargement of the Thymus in Infants with Special Reference to Clinical Evidence of So-called Status Thymico-lymphaticus

By ALAN MONCRIEFF, M.D.

(From the Children's Department and the Meyerstein Institute of Radiotherapy, Middlesex Hospital; and the Hospital for Sick Children, Great Ormond Street)

DURING the past few years I have made careful observations of 12 young children presenting various symptoms which appeared to be associated with enlargement of the thymus gland as shown on X-ray examination of the thorax. Certain of these symptoms are well recognized, but others are less frequent and less understood, and I particularly wish to draw attention to the occurrence of "attacks" of what appears to be a mixture of syncope and dyspnœa such as was present in the history of the four patients shown in the clinical meeting to-day, of whom more details are given below.

My object in bringing this subject and these patients before this Section is to secure more interest in what may be termed the clinical aspects of thymic enlargement as distinct from pathological considerations. In this country the condition termed "status thymico-lymphaticus" is out of scientific favour. Greenwood and Woods (1927), who greatly helped in clarifying the controversial aspects of this subject by a statistical approach, admitted, however, that their concern was with pathological material since, in their view, the condition could not be diagnosed during life. Similarly the careful pathological report by Young and Turnbull (1931) was concerned with post-mortem material in relation to cause of death. It is true that a certain amount of criticism is applied by those with the pathological view in mind to the so-called clinical stigmata of the status thymico-lymphaticus, and I do not intend here to attempt any resuscitation of Paltauf's theory. But radiological evidence has been accumulating since the time of the two important contributions mentioned above, and with the aid of this it is now possible to obtain knowledge as to the size of the thymus during life. Moreover, such size can be varied to some extent by treatment, and after treatment certain symptoms disappear or are altered. It seems to me fair, therefore, to lodge a mild protest against the sweeping implications of the title of a leading article in the *Lancet* (1931 (i), 593) called "The end of status lymphaticus" when all that was proved up to that period was that there "was no evidence that so-called status thymico-lymphaticus had any existence as a pathological entity". I prefer to range myself with Wright (1937) who in a careful review of the physiology of the thymus gland, says in regard to status thymico-lymphaticus that the whole subject needs further investigation.

No attempt is made here to analyse the huge literature on the thymus problem. Some details of this can be obtained in the contribution by Greenwood and Woods

already mentioned and Rolleston (1936) has given an admirable summary in his valuable book on endocrines. I propose to pass straight on to a consideration of the clinical features of my 12 patients.

Clinical Features

Of the 12 patients, 10 were males and two females, a male sex dominance which others have noted. Symptoms occurred at an early age (before 4 months) in all except one in whom " attacks " began at the age of 3 years. The principal symptoms were as follows : Stridor only (five cases), syncope and dyspnœa (three cases), head retraction, one also with syncope (two cases), cyanotic attacks (one case), " fits " (one case), dyspnœa only (one case). In one patient infantilism was also present. All the patients showed an enlarged thymus on X-ray examination. It may be said here that X-ray examination of a certain number of normal healthy infants attending at a Welfare Centre has failed to reveal examples of thymic enlargement similar to those present in the cases here described nor is an enlarged thymus a common chance finding in the chests of those infants and young children who are submitted to an X-ray examination for suspected disease of the heart or lungs.

Stridor.—Of the five patients with stridor it is not proposed to say more than a few words, and I am also omitting clinical details in order to save space. The clinical picture with noisy breathing and signs of respiratory obstruction is well known. Two practical points may, however, be briefly made. First, in one patient affected by stridor since 4 months of age, whom I saw at the age of 3½ years on his return from abroad, there had been a complete cessation of symptoms on two occasions when he was most seriously ill with diarrhœa and sickness. It is recognized that dehydration may reduce the size of the thymus and presumably this history may be taken to mean that these two dehydrating illnesses temporarily relieved pressure of a thymus gland subsequently shown, by X-ray examination, to be enlarged. The second point concerns the diagnosis of so-called " congenital laryngeal stridor ". The theories of the ætiology of this condition usually advanced have always failed to convince me, and since I began to submit all stridorous babies to a careful X-ray examination I find that the number of instances of congenital laryngeal stridor diagnosed by elimination is greatly decreased. May it not be that thymic stridor explains more of these cases than is generally realized ?

Syncope and dyspnœa.—The patients with what I have called " syncope and dyspnœa " are to me the most interesting group. Four of these were demonstrated here to-day and the following are the details of clinical findings and treatment.

(1) *Enlarged Thymus : Head Retraction and " Fits "*

D. L., male, born April 1937. Admitted to Middlesex Hospital, first at the age of 6 weeks on account of head retraction. No evidence of meningitis was found and the head could easily be flexed, although the child preferred to lie with it held back. He was discharged after one week. Thereafter he began to have curious " attacks " in which the head was thrown back, the limbs became stiff, and the colour became blue. The attacks lasted three or four minutes and might occur several times a day.

He was admitted again and X-ray examination 16.7.37 showed enlarged thymus. Radiation treatment (*see below*). The child was very ill after this, with vomiting and diarrhœa (? radiation as cause of this). No more attacks in hospital. Subsequent X-ray examinations showed decrease in size of the thymus shadow (figs. 1 and 2). Seen at beginning of November 1937—no more " blue " attacks but is still inclined to hold his head back at times.

Treatment (31.8.37).—Surface application radium to area of thymus. Area, 26 sq. cm. ; distance, 1 cm. ; filtration, 1 mm. platinum ; time, 16 hours ; dose, 660 r to skin (110 r estimated to thymus).

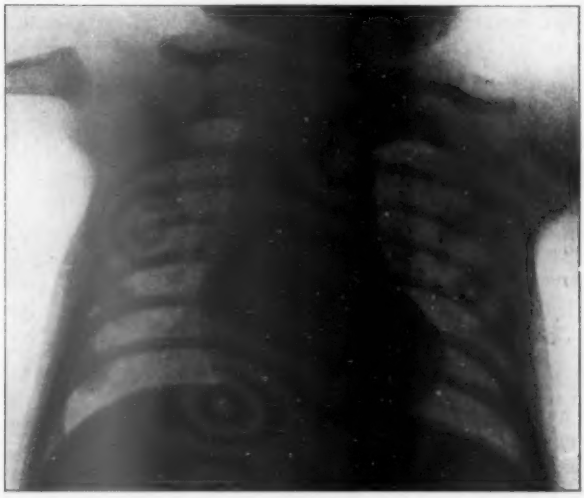


FIG. 1.—Case 1. Before treatment.

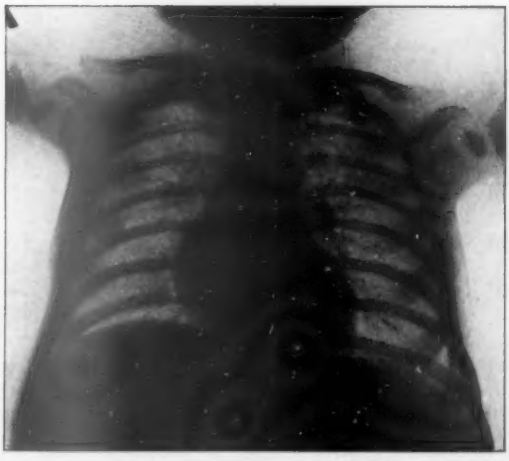


FIG. 2.—Case 1. After treatment (3 months later).

(2) *Enlarged Thymus : " Fits "*

B. Y., male, born February 1935. Seen at the age of one day in Queen Charlotte's Hospital and at intervals ever since. Had curious cyanotic attacks in early days of life not accounted for by any obvious condition in lungs, heart, or brain. The next symptoms were " fainting " attacks during feeding. Later he developed attacks of shortness of breath—" used to pant a lot "—quite suddenly, while playing or after food.

X-ray examination (26.6.36) : Large thymus shadow. Radiation treatment (*see below*). Subsequent X-ray examinations showed decrease in size of thymus shadow. No attacks of fainting or shortness of breath since treatment.

Treatment (27.6.36).—Surface application of radium to area of thymus. Area 39 sq. cm. ; distance, 1 cm. ; filtration, 1 mm. platinum ; time, 10 hours ; dose, 850 r to skin (330 r estimated to thymus).

29.7.36 : Area, 34 sq. cm. ; distance, 1 cm. ; filtration, 1 mm. platinum ; time, 6 hours ; dose, 680 r to skin (240 r estimated to thymus).

(3) *Enlarged Thymus : " Fits "*

J. B., male, born February 1936. Attended out-patient department at Middlesex Hospital when aged 3 months, with the history of having had a " fit " at the age of 10 weeks. The fit was not seen but a foster-mother found the baby unconscious. Given a hot bath and came round. Since then several further " attacks " have occurred in which the baby becomes blue, breathes rapidly but shallowly, and is very limp. He does not sleep after attacks, which last about half an hour, but is limp and " depressed ".

X-ray examination (21.11.36) : A large thymus shadow. Radiation treatment (*see below*). Subsequent X-ray examinations showed a decrease in size of thymus shadow (*see* figs. 3 and 4). Complete cessation of all " attacks ". The child made

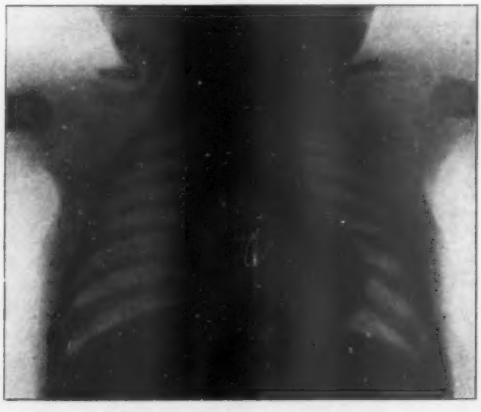


FIG. 3.—Case 3. Before treatment.

excellent progress except for gastro-enteritis in December 1936. In January 1938 he developed a " cold " and vomited. After this he " fainted " as in previous attacks. X-ray examination (11.1.38) : Thymus shadow still small.

Treatment (26.11.36).—Surface application radium to area of thymus. Area, 30 sq. cm. ; distance, 1 cm. ; filtration, 1 mm. platinum ; time, 6½ hours ; dose, 800 r to skin (272 r estimated to thymus).

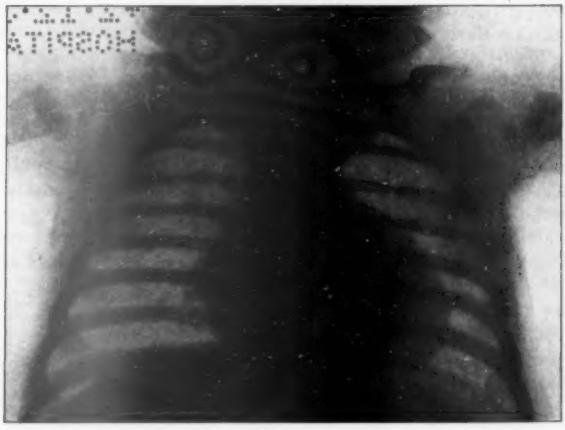


FIG. 4.—Case 3. After treatment (14 days later).

(4) *Enlarged Thymus: "Fits" and Infantilism*

A. C., male, born December 1933. First seen at the age of 3 months, with œdema of legs, caused by a truss used for inguinal hernia. At the age of 3 years he began to have curious turns in which he "goes pale, pants for breath, and looks as if he were going to fall down". He was noted to be curiously infantile for his age.

X-ray examination (30.12.36): Broad mediastinum. Radiation treatment (*see below*). Subsequent X-ray examinations showed slight decrease in thymus shadow. No more "attacks". No cause for infantilism found.

Injections of antuitrin G began September 1937, but had no effect upon growth. The attacks occurred again and further radiation was applied.

Treatment (25.3.37).—Surface application of radium to area of thymus. Area, 32 sq. cm.; distance, 1 cm.; filtration, 1 mm. platinum; time, 7¼ hours; dose, 800 r to skin (300 r estimated to thymus).

26.11.37: Deep X-ray treatment to thymus. Kilovolts, 200; milliamps, 6; filtration, 1 mm. copper; focal skin distance, 40 cm.; field, 6 × 8 sq. cm. over thymus; dose, 600 r to skin in 6 daily doses of 100 r estimated to thymus.

Before discussing various aspects of these cases I would like to add some clinical records of the three other patients who did not have stridor.

(5) *Enlarged Thymus: "Fits"*

D. S., male. Attended the Hospital for Sick Children, Great Ormond Street, on 14.4.37 at the age of 3 months with the history that for the last three weeks he had suffered from "attacks" in which his eyes rolled, and his head seemed to shake. The whole attack lasted only a few seconds. The attacks occurred several times a day and at night. X-ray examination (14.4.37) showed some vague increased shadowing in the upper mediastinum, but this was not considered definite enough to warrant treatment. Bromide, 3 gr. three times a day, was given without effect upon the attacks. After a fortnight's treatment the attacks were more frequent and more prolonged, and appeared much more like epilepsy. He was admitted for radiation treatment to the thymus (*see* page 32) in May 1937. He was not brought back again (despite correspondence with the mother) until 8.12.37. It was then reported that

there had been a complete cessation of the attacks after the radiation. X-ray examination on this date showed that the upper mediastinal shadow was smaller.

Treatment (May 1937).—Radium bib, 40 mgm. for sixteen hours.[1]

(6) *Enlarged Thymus : Dyspnœa*

G. A., male. Attended the Hospital for Sick Children, Great Ormond Street, first at the age of 1 year on account of " rapid breathing ". Chest deformity (slight Harrison's sulcus) had been noted from birth. Breathing was rapid at times, when he was playing or running about, but was never noisy. X-ray examination (1.5.36) showed enlargement of the thymus. Radium treatment was given. Breathing was slightly improved. Further X-ray examination (13.10.36) showed a smaller shadow and there were subsequently no further respiratory symptoms. X-ray examination on 16.6.37 showed a normal mediastinum. The shape of the chest has remained poor.

Treatment (15.5.36).—Radium bib, 40 mgm. radium for sixteen hours.

(7) *Enlarged Thymus : Head Retraction*

C. R., male. He was seen by me privately at the age of 3 months because there was some doubt about his vision and he was noticed " to hold his head back "—which according to his mother he had always done and would make no effort to hold up his head. No attacks of dyspnœa or fainting. X-rays (18.12.37) showed a large thymic shadow. Radiation treatment given (20.12.37). X-rays on 1.1.38 showed great decrease in thymus shadow. No improvement in condition of head retraction.

. . . . .

It will be seen that among these seven patients are some who exhibit more than one symptom. The last patient (Case 7) with head retraction alone, closely resembles the first patient (Case 1) in his earliest stages, but when I first saw Case 1 and the question of meningitis was eliminated I did not seriously consider thymic enlargement as a cause of the condition. It was only when the attacks of stiffness, opisthotonos, and cyanosis developed that X-ray examination was made. In Case 7 radiation treatment has been used with the idea of preventing the development of any such " attacks ". Case 2 is of particular interest to me since I have observed the infant closely from the very early age of 1 day. In the first year of life he had cyanotic attacks (in the neonatal period), passing on to what the mother described as fainting attacks during feeding and later developing curious paroxysms of rapid breathing (without stridor). I had at times heard a fleeting systolic murmur over the heart and X-ray examination was originally undertaken in order to try and find evidence of possible congenital heart disease. The enlarged thymus then discovered was a surprise, but it is significant that all his attacks have ceased since the size of the thymus was reduced by radiation. He has occasional attacks of bronchitis and it is proposed to remove his adenoids in the spring. Case 3 has presented the most alarming symptoms of the whole group. The child was first found unconscious in his cot at the age of 10 weeks. In subsequent attacks he has become blue, with rapid breathing and a curious limpness which the mother describes as most alarming.

I should like here to point out the possible connexion between such an " attack " and the not infrequent tragedy in which a previously healthy infant is found dead in cot or perambulator without any adequate cause being discovered. With some coroners and pathologists the existence of an enlarged thymus in such a case justifies the diagnosis of " status lymphaticus ", but these are just the circumstances which the school of Greenwood and Turnbull particularly criticize. Having heard the mother's description of how her infant (Case 3) has appeared " like dead " on these occasions I find myself compelled to accept the connexion between the symptoms

[1] Dr. Bertram Shires has kindly supplied the following details of this treatment. The " radium bib " is made up with 40 mgm. of radium element on a plaque of 3 in. by 2 in. filtered with ½ mm. of lead. The bib is tied on with straps round the neck and under the arms so as to give radiation to the whole of the thymic area. It is applied for sixteen hours.

—severe syncope and collapse—and the enlarged thymus, since a decrease in the size of the thymus effected by radium brought about a cessation of all attacks for over a year. A slight exaggeration of the symptoms would possibly bring about a fatal termination in such a patient, and it is particularly in cases of this character that prompt recognition of the nature of less serious attacks and their treatment by radiation of the thymus is so important.

Case 4, that with infantilism, is shown without special comment, for the dwarfing may or may not have some connexion with the thymic enlargement. It is perhaps significant that there has been no growth whatever even after the injection of a powerful pituitary preparation.[1] The attacks have never been so serious as in Case 3 and the child is much older than the others in the series. Cushing (1912) has pointed out that in human hypopituitarism the thymus undergoes hyperplasia.

Case 5 is of some importance in that the "attacks" described were very like epileptic fits, and it was only when bromide failed to produce any improvement that X-ray examination of the thymus was made. The prompt cessation, after radiation treatment, of the fits—which were occurring several times a day—is significant.

Case 6 shows the paroxysms of dyspnœa without stridor which have been termed "thymic asthma". Of Case 7 with head retraction as a sole manifestation of thymic enlargement, mention has already been made.

Discussion

This condition of syncope, dyspnœa, and fits in young infants, associated with thymic enlargement, does not appear to have been recognized sufficiently in this country although from Canada, in particular, there have been several communications dealing with the subject. Morgan, Rolph, and Brown (1927) have discussed the clinical manifestations of thymic enlargement in a group of over 50 cases. The order of frequency of symptoms was: Breath-holding (sometimes followed by unconsciousness), syncope (probably the most serious manifestation of thymic disturbance), cyanosis, cough, "noisy nasal breathing", choking attacks, thymic asthma, and rapid panting respiration. Kirkland (1930) has also discussed various symptoms associated with thymic enlargement—such as mild or moderate cyanosis associated with difficulty in feeding, convulsions (varying from faint twitchings to alarming attacks with dyspnœa), and also attacks of death-like pallor with absolute flaccidity. Kemp (1933) describes similar symptoms and uses the phrase "mild status lymphaticus" for a syndrome which includes "air hunger, often accompanied by croupy respiration, cyanosis and, frequently, collapse". He describes the collapse and ashy pallor of some of his cases and indicates that attacks may be precipitated by crying or temper, following upon breath-holding.

All these authors write from Canada, and if I refrain from quoting more extensively in the literature, it is because in other parts of the world more attention is paid to what may be called the "noisy" type of thymic symptoms (stridor and choking spells) and less to the quieter and more alarming types of syncope. To make the subject even more difficult, Kirkland notes that any of the thymic symptoms he describes may be present with a normal thymic shadow, on X-ray examination. Radiation to the thymus in such cases, however, improves the symptoms. Moreover, in other instances, although radiation treatment has brought about a cessation of symptoms an enlarged thymus shadow may persist in X-ray pictures.

I mention these difficulties here because in discussing the connexion between thymic enlargement and the symptoms described, there are many obscurities present. It seems significant that the purely stridor cases in my small series never presented any of the other symptoms here described nor did any of the seven non-stridorous group ever suggest any obvious pressure upon or obstruction of the respiratory passages, with the exception of Case 6 in which a chest deformity and noiseless,

[1] Messrs. Parke, Davis kindly put a supply of antuitrin G at my disposal.

rapid breathing in paroxysms had existed since an early age. It is difficult therefore to accept pressure as the sole cause of the symptoms, although it is tempting to imagine that pressure on the vagus, or on the large vessels at the base of the heart, might be present and be suddenly increased by venous congestion brought about by crying, choking, coughing, or breath-holding. The alternative theory is to assert that excessive internal secretion from the thymus antagonizes the cortical secretion of the adrenals. Kemp (1933, 1937) has elaborated this theory and claims good results with a desiccated preparation of the adrenal cortex by the mouth. I fear that I cannot follow him in the whole theory of attributing " status lymphaticus " symptoms or death to cortico-adrenal insufficiency, nor have I the courage to withhold radiation treatment while carrying out a trial of a potent cortical adrenal hormone.

Treatment

This is a highly technical matter, into the details of which I do not propose to enter. For young babies the use of X-rays clearly presents many difficulties, and for them the " radium-bib " as used by Dr. Bertram Shires, offers great advantages. Moreover therapeutic X-ray plants are not easily available and the radium treatment can be given even in a patient's home. Friedmann (1933) has urged that there are more reactions after radium, and recommends high-voltage X-rays as the method of choice. I cannot judge finally about this, for it seems to me that reactions would be a matter of dosage, whatever form of radiation was used. I may sum-up my opinion on treatment by saying that as soon as possible after an enlarged thymus has been proved by X-ray examination, in an infant displaying the alarming symptoms recorded above, the size of the thymus should be reduced by suitable radiation, the form of which can be left to the expert.

I should like to express my sincere thanks to Dr. Brian Windeyer and Dr. Bertram Shires for their skilful co-operation in the treatment of the tiny patients here described.

References

Cushing, H. (1912), " The Pituitary Body and its Disorders ", Philadelphia, p. 282.
Friedmann, L. J. (1933), *Radiology*, **20**, 380.
Greenwood, M., and Woods, H. (1927), *J. Hyg.*, **26**, 305.
Kemp, W. N. (1933), *Canad. M. A. J.*, **29**, 506.
Id. (1937), *Brit. M. J.*, **1**, 1194.
Kirkland, A. S. (1930), *Canad. M. A. J.*, **23**, 661.
Morgan, E. A., Rolph, A. H., and Brown, A. (1927), *J. A. M. A.*, **88**, 703.
Rolleston, H. (1936), " The Endocrine Organs in Health and Disease ", Oxford.
Wright, S. (1937), " The Endocrines in Theory and Practice ", London, p. 233.
Young, M., and Turnbull, H. M. (1931), *J. Path. and Bact.*, **34**, 213.

Discussion.—Dr. Maitland-Jones said that he was somewhat doubtful as to whether Dr. Moncrieff had established his case. In the first place, the clinical features varied so much that it was difficult to see how they could all be produced, directly or indirectly, by thymic enlargement. Secondly, the interpretation of the X-ray photograph was a matter of great difficulty; for example, the width of the mediastinal shadow at the base of the heart varied with respiration, and he was not prepared to admit that the films shown by Dr. Moncrieff gave conclusive evidence of thymic enlargement.

An important point made in the paper was that symptoms were relieved by radiation of the thymus, but here again in one case, despite treatment, symptoms had recurred. For many years he (the speaker) had watched for examples of thymic enlargement with symptoms, but up to the present he had not seen such a case.

Dr. Wilfrid Sheldon wondered whether Dr. Moncrieff had had lateral views of the chest taken to see whether the enlarged thymus had caused any flattening or backward displacement of the trachea. He had been given to understand that this was to be found, although he himself could not recall having seen any deformity of the trachea.

There was sometimes a history in these cases of a baby collapsing when put into its bath, and he would like to know whether this had been so in Dr. Moncrieff's cases.

Dr. N. B. Capon suggested that sometimes the shadows seen by X-rays in these cases were caused by dilatation of the auricles rather than by enlargement of the thymus.

Granuloma Annulare.—C. E. FIELD, M.D. (by courtesy of REGINALD LIGHTWOOD, M.D.).

Iris S., aged 4 years and 3 months, is the younger of two healthy children. Both parents are healthy. Apart from measles and pertussis she has had no illnesses.

History.—About two years ago the buckle of her shoe rubbed her ankle. This appeared to cause a round, raised, white patch, which gradually enlarged. During the last nine months it has increased still more rapidly.

Present state.—A healthy child. On the antero-lateral aspect of the left leg at the distal end, and extending on to the lateral malleolus, is a circumscribed area $3\frac{3}{4}$ in. in diameter. The edge is firm, raised, and indurated; it is more marked on the distal aspect. In the centre of this area there are numerous small raised nodules between which the skin appears normal.

The Mantoux reaction (1 : 1,000) is negative.

Ætiology.—This disease is a comparatively rare chronic condition of the skin, lasting from a few months to several years. It is thought to be a blood-borne toxic manifestation, probably of tuberculous origin, this being supported by the histological findings. There is frequently a family history of tuberculosis, and in about ten per cent. of cases an associated tuberculous lesion is found elsewhere on the patient, often taking the form of lupus vulgaris. But, according to Halliwell and Ingram,[1] the Mantoux reaction is negative in forty-three per cent. of cases, as it was in this patient.

Treatment.—Small doses of X-rays usually result in a rapid disappearance although it is liable to recur.

? Congenital Varicose Veins of Forearm. — E. HENRIETTA JEBENS, F.R.C.S.

M. S., female, aged 4 years.

History.—Swellings on left arm and hand noticed fourteen days after birth. Brought to hospital when 3 weeks old, in February 1934. Examination then showed the following: (1) Firm swelling the size of a hazel-nut, not attached to skin or deep structures in the region of the epitrochlear gland. (2) Diffuse swelling of lower end of ulnar side of forearm with firm nodule in centre. (3) Small bluish swellings on dorsum of fingers. The swelling in the epitrochlear region gradually became smaller and had disappeared by February 1935. Several other swellings have appeared along the ulnar border and on the dorsum of the forearm and hand, some of which have disappeared again within a few months. A bluish discoloration of the skin precedes the formation of a swelling. The child has never complained of pain, but some of the swellings have been slightly tender when touched. In September 1937, a bluish swelling appeared on the ulnar side of the dorsum of the wrist. This was removed for microscopy. No history of trauma.

Present condition.—Several small swellings over dorsal aspect of forearm. Diffuse swelling over ulnar border of lower end of forearm; firmer nodules can be palpated within this swelling. Small bluish swellings over dorsum of fingers; another developing on dorsum of hand. The swellings are firm, do not disappear on raising of arm, and cannot be emptied by pressure. Length of arm equal to that of unaffected side. Circumference is increased $\frac{1}{8}$ in. in upper part, and $\frac{1}{4}$ in. in lower part of forearm. No obvious difference in temperature between the two sides. The child uses the arm and hand normally and muscle-power appears to be unaffected. All joints are normal.

Operation.—Small cyst, containing a small quantity of very dark blood, removed from dorsal aspect of wrist. It did not appear to be in continuity with a vein of any size; there was no bleeding after its removal.

[1] Halliwell and Ingram (1935), *Brit Journ. Derm. and Syph.*, **47**, 319.

Pathologist's report: "Section shows an extremely thin-walled cyst. The principal tissue seems to be angiomatous and very degenerate. There is no evidence of sarcoma and no inflammatory basis for the subcuticular hæmorrhage."

Radiologist's report: "Bones of forearm appear normal."

Wassermann reaction negative.

The PRESIDENT said he thought that the condition must be due to a local developmental aberration of the vessels in the limb, associated with occasional thrombosis. He did not consider that treatment by excision or radium would help.

Hepatomegaly in an Infant: ? Von Gierke's Disease.—G. H. NEWNS, M.D. (by courtesy of R. S. FREW, M.D.).

Pamela C., aged 6½ months, was brought to the out-patient department of the Hospital for Sick Children in November 1937 because of dyspeptic vomiting. On routine examination, the liver was found to be enlarged.

Family history.—There is one other child aged 10 years; she is quite well. Two children have died, one at the age of 16 months (cause ? encephalitis); the other child had an enlarged liver and died at the age of 8 months. The autopsy revealed gross infiltration of the liver with fat.

On examination.—The infant was in good condition and well covered. The liver was enlarged, the lower edge being felt just above the umbilicus. The spleen was not felt. There were no other abnormal signs.

Investigations (Dr. W. W. Payne).—Urine: No albumin, sugar, or acetone. Many leucocytes present. Culture gave a heavy growth of late-lactose fermenters. Wassermann reaction negative.

Blood cholesterol 390 mgm. per 100 c.c. Blood glycogen: Whole blood 18·8 mgm. per 100 c.c. Plasma 5 mgm. per 100 c.c.

Lævulose tolerance test:

Fasting blood-sugar	0·048 grm. per 100 c.c.
½ hour after giving 13 grm. lævulose ...	0·041 ,, ,,
1 ,, ,, ,, ,, ...	0·041 ,, ,,
1½ hours ,, ,, ,, ...	0·047 ,, ,,
2 ,, ,, ,, ,, ...	0·053 ,, ,,

Adrenaline test:

Fasting blood-sugar	0·041 grm. per 100 c.c.
¼ hour after adrenaline	0·033 ,, ,,
½ ,, ,, ...	0·033 ,, ,,
¾ ,, ,, ...	0·033 ,, ,,
1 ,, ,, ...	0·035 ,, ,,

Progress.—The vomiting has ceased and the infant is now gaining weight. The urinary infection has not yet cleared up. The liver is less enlarged than it was on admission.

The report of other cases shown at this meeting will be published in the next issue of the PROCEEDINGS *of the Section.*